THURSDAY, AUGUST, 5, 1880

MULTIPLE SPECTRA[1]

II.

I CONCLUDED my last article under the above heading with a reference to the case of carbon, and gave the results successively arrived at by Attfield, Morren, Watts, and others, which went to show that besides the line-spectrum of carbon mapped by Ångström there exists a fluted spectrum of this substance.

Now comes my own personal connection with this matter.

In the year 1878[2] I communicated to the Royal Society a paper in which the conclusion was drawn that the vapour of carbon was present in the solar atmosphere.

This conclusion was founded upon the reversal in the solar spectrum of a set of flutings in the ultra-violet.[3] The conclusion that these flutings were due to the vapour of carbon, and not to any compound of carbon, was founded upon experiments similar to those employed in the researches of Attfield and Watts, who showed that the other almost exactly similar sets of flutings in the visible part of the spectrum were seen when several different compounds of carbon were exposed to the action of heat and electricity. In my photographs the ultra-violet flutings appeared under conditions in which carbon was the only constant, and it seemed therefore reasonable to assume that the flutings were due to carbon itself, and not to any compound of carbon; and this not alone from the previous work done in the special case of carbon, but from that which had shown that the fluted spectra of sulphur, nitrogen, and so forth were really due to these "elementary" substances.

Professors Liveing and Dewar have recently on several occasions called this result in question. Prof. Dewar, in a paper received by the Royal Society on January 8, 1880, writes as follows :—

"The almost impossible problem of eliminating hydrogen from masses of carbon, such as can be employed in experiments of this kind, prove conclusively that the inference drawn by Mr. Lockyer, as to the elementary character of the so-called carbon spectrum from an examination of the arc in dry chlorine, cannot be regarded as satisfactory, *seeing that undoubtedly hydrogen was present in the carbon* used as the poles."

Subsequently in a paper received by the Royal Society on February 2, Messrs. Liveing and Dewar wrote as follows :—

"Mr. Lockyer (*Proc. Roy. Soc.*, vol. xxvii. p. 308) has recently[4] obtained a photograph of the arc in chlorine, which shows the series of fluted bands in the ultra-violet, on the strength of which he throws over the conclusion of Angström and Thalèn, and draws inferences as to the existence of carbon vapour above the chromosphere, in the coronal atmosphere of the sun, which, if true, would be contrary to all we know of the properties of carbon. We cannot help thinking that *these bands were due to the presence of a small quantity of nitrogen*."

It will be seen that on January 8 Mr. Dewar alone attributed the flutings to a hydrocarbon, while on February 2 Mr. Dewar, associated with Mr. Liveing, attributed them to a nitrocarbon.

[1] Continued from p. 7.
[2] *Proc. R. S.*, No. 187, 1878.
[3] The approximate wave-length of the brightest member on the least refrangible edge is 3881·0.
[4] That is, in 1878.—J. N. L.

In fact in the latter paper Messrs. Liveing and Dewar published experiments on the spectra of various carbon compounds, and from their observations they have drawn the conclusion that the set of flutings which I have shown to be reversed in the solar spectrum is really due to *cyanogen*, and that certain other sets of flutings shown by Attfield and Watts to be due to carbon are really due to hydrocarbon.

As Messrs. Liveing and Dewar do not controvert the very definite conclusions arrived at by Attfield, Morren, Watts, and others, I can only presume that they took for granted that all the experimental work performed by these men of science was tainted by the presence of impurities, and that it was impossible to avoid them. I therefore thought it desirable to go over the ground again, modifying the experimental method so as to demonstrate the absence of impurities. Indeed I have started upon a research which will require some time to complete. Still, in the meantime, I have submitted to the notice of the Royal Society some results which I have obtained, which I think settle the whole question, and it is the more important to settle it as Messrs. Liveing and Dewar have already based upon their conclusions theoretical views which appear to me likely to mislead, and which I consider to have long been shown to be erroneous. To these results I shall now refer in this place.

The tube with which I have experimented is shown in Fig. 1: A and B are platinum wires for passing the spark inside the tube; E is a small tube into which carbon tetrachloride was introduced; it was drawn out to a long narrow orifice to prevent the rapid evaporation of the liquid during the exhaustion of the tube. The tube was bent upwards and a bulb blown at C in order that the spark might be examined with the tube end-on, as it is found that after the spark has passed for some time a deposit is formed on the sides of the bulb immediately surrounding the platinums, thus obstructing the light. After a vacuum had been obtained the tube was allowed to remain on the Sprengel pump, to which it was attached by a mercury joint for the purpose of obtaining a vacuum for a long time, in order that the last traces of air and moisture might be expelled by the slow evaporation of the liquid.

The carbon tetrachloride was prepared by Dr. Hodgkinson, who very kindly supplied me with sufficient for my experiments.

On passing the spark without the jar in this tube, the spectrum observed consists of those sets of flutings which, according to Messrs. Liveing and Dewar, are due to hydrocarbon, and the set of flutings which is reversed in the sun, and ascribed by Messrs. Liveing and Dewar to cyanogen, also appears in a photograph of the violet end of the spectrum, Fig. 2. On connecting a Leyden jar with the coil and then passing the spark the flutings almost entirely vanish and the line spectra of chlorine and carbon take the place of the flutings without either a line of hydrogen or a line of nitrogen being visible.

As a long experience has taught me that these tubes often leak slightly at the platinums after they are detached from the pump, so that the evidence of such a *pièce justificatif* is only good for a short time, I took the occasion afforded by a visit of Dr. Schuster to my laboratory while

the experiments were being made to get my observations confirmed. He has been good enough to write me the following letter and to allow me to give it here:—

"*March* 21

"MY DEAR LOCKYER,—The following is an account of the experiment which I saw performed in your laboratory on Monday, March 15:—

"A tube containing carbon-tetrachloride was attached to the Sprengel pump. As exhaustion proceeded the air was gradually displaced by the vapour of the tetrachloride. The electrodes were a few millimetres apart. If the spark was taken without a condenser in the vapour the well-known carbon bands first observed by Swan in the spectrum of a candle were seen with great brilliancy; I also saw the blue band which you said was identical in position with one of the blue bands seen in the flame of cyanogen or in the spectrum of the electric arc. When the condenser and air-break were introduced this spectrum gave way to a line spectrum in which I could recognise the lines of chlorine. *The lines of nitrogen were absent, not a trace of the principal double line in the green being seen.* The hydrogen line Hα(C) was faintly visible when I first observed the spectrum, but it got gradually weaker and *finally disappeared altogether. When this line was no longer visible the condenser was taken out of circuit*

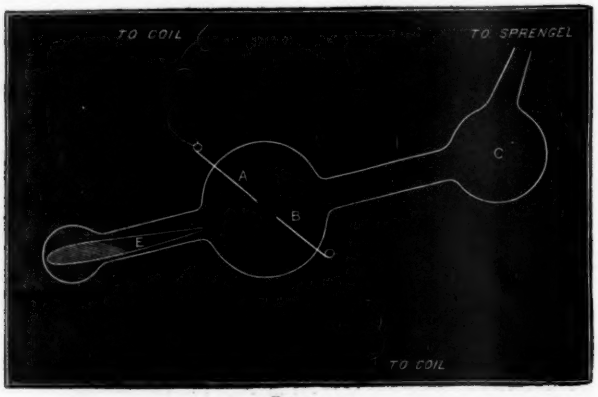

FIG. 1.

again, and the same carbon bands were seen as before. These bands, therefore, show themselves with great brilliancy when a strong and powerful spark does not reveal the presence either of hydrogen or nitrogen.

"March 21, 1880 (Signed) ARTHUR SCHUSTER"

This result, which entirely endorses the work of Attfield and Watts, has been controlled by many other experiments. I have also repeated Morren's experiment and confirm it, and I have also found that the undoubted spectrum of cyanogen is visible neither in the electric arc nor in the surrounding flame.

Hence then in the case of carbon, as in the prior cases of hydrogen, nitrogen and the like, those who hold that the flutings are due to impurities must, it would seem, abandon their position; for the flutings are undoubtedly produced by carbon vapour. Nor is this all; the suggestion that the various difficulties which have always been acknowledged to attend observations of this substance may in all probability be due to the fact that the sets of carbon flutings represent different molecular groupings of carbon, in addition to that or those which give us the line spectrum, and that the tension of the current used now brings one set of flutings into prominence and now another, seems also justified by the facts. This suggests

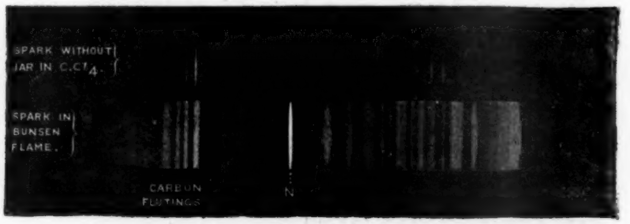

FIG. 2.

the view that a body may have a fluted spectrum of compound origin as well as a line spectrum.

This conclusion is greatly strengthened by the preliminary discussion of a considerable number of photographs of the spectra of various carbon compounds.

A general comparison of the photographs first enables us to isolate the lines in the blue and ultra-violet portions of the spectrum (wave-lengths 4300–3800) of the substance associated with the carbon in each case.

In this manner the lines seen in the photographs of the spectra of CCl_4, $C_{10}H_8$, CN, CHI_3, CS_2, CO_2, CO, &c., have been mapped, and both the common and special lines and flutings thus determined.

The phenomena seen with more or less constancy are a blue line, with a wave-length of 4266; a set of blue flutings, extending from 4215 to 4151; and another set of ultra-violet flutings, which extend from 3885 to 3843 (all approximate numbers).

In a photograph of the spectrum of the electric *arc* (with a weak battery) between carbon poles in an atmosphere of chlorine, the blue flutings alone are visible, whilst, when the *spark* is similarly photographed, the ultra-violet flutings and the blue line (4266) are also visible, whilst the blue flutings become fainter.

From this we may assume, in accordance with the working hypothesis of a series of different temperature furnaces, as set forth in the paper of December, 1878 (see Fig. 3), that the different flutings and the line correspond to different temperature spectra, the blue flutings to the lowest and the blue line to the highest temperature, whilst the ultra-violet flutings occupy an intermediate position.

FIG. 3.—Action of three different temperatures on a hypothetical substance, assuming three stages of complete dissociation.

According to this working hypothesis there should be a series of horizons forming a perfect gradation between the spectrum which contains the blue line alone and that which contains the blue fluting alone (Fig. 4). In comparing the spectra of carbon under different conditions, I find this to be true. *The blue line never appears in conjunction with the blue flutings, unless the ultra-violet flutings are also present.* In other words, the highest and the lowest hypothetical temperature spectra are never visible together without the spectrum of the intermediate hypothetical temperature.

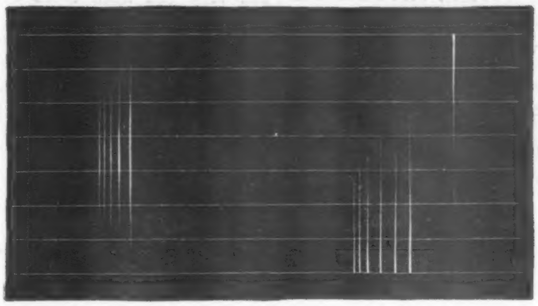

FIG. 4.—Spectra of the hypothetical substance in intermediate furnaces, assuming that the vapours are not completely dissociated.

But this is not all. By placing the spectra of the substances at different heat-levels, so to speak, I was enabled to construct a map, which not only indicates the mere presence or absence of the lines and their relative intensities, but shows a perfect gradation between the spectrum which contains the line alone and that which contains the blue flutings alone (Fig. 5). I would point out that there is nothing theoretical in this map. All the horizons depicted are copied from photographs of carbon under the conditions indicated, and theory has merely enabled me to arrange them *in order*.

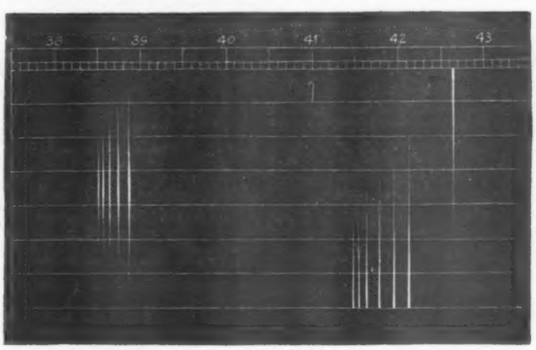

FIG. 5.—The photographed spectra of some carbon compounds.

This map I submit, therefore, bears out the hypothesis of differences of temperature indicated above, for it is seen that, while the blue line gradually thins out, the ultra-violet flutings appear first and grow in intensity. As these increase the blue flutings become visible, and further, as the latter augments and the line disappears, the ultra-violet flutings gradually die out altogether.

It is philosophical to infer from these observations that not only are the line and flutings in question produced by carbon, but that the blue line (4266), since it is visible at the highest temperature, corresponds to the most simple molecular grouping we have reached in the experiments, and the flutings to others more complex.

The result to which attention is most to be directed in this place is that touching the two sets of flutings, and should future research justify the double conclusion (1) that these flutings are truly due to carbon, a result I accept, though it is denied by Ångström and Thalèn; and (2) that the different flutings really represent the vibrations of different molecular groupings; a great step, and one in the direction of simplification, will have been gained.

Indeed it is much to be hoped that this ground will be at once worked over again by men of science who are both honest and competent: that the truth is sure to gain by such work is a truism.

I have so often taken occasion to refer with admiration to the work of Ångström and Thalèn that I shall not be misunderstood when I say that their conclusions, to which such prominence is given, and on which such great stress is laid by Messrs. Liveing and Dewar, rest more upon theory and analogy than upon experiment.

Their work, undertaken at a time when the existence of so-called "double spectra" was not established upon the firm basis that it has now, and when there was no idea that the spectrum recorded for us the results of successive dissociations, gave, as I have previously taken occasion to state, the benefit of the doubt in favour of flutings being due to compounds, and it was thought less improbable that cyanogen or acetylene should have two spectra than that carbon or hydrogen should possess them.

Indeed, later researches have thrown doubt upon the view that the fluted spectra of aluminium and magnesium are entirely due to the oxides of those metals instead of to the metals themselves—and this is the very basis of the analogy which Ångström and Thalèn employed.

The importance of the observations to which I have referred is all the greater because of the general conclusions touching other spectra which may be drawn from them. Thus from what I have shown it will be clear that if my view is correct the conclusions drawn[1] by Messrs. Liveing and Dewar from the assumed hydrogen-carbon bands touching both the spectrum of magnesium and the spectra of comets, are entirely invalid. These conclusions are best given in their own words:—

"The similarity in the character of the magnesium-hydrogen spectrum, which we have described, to the green bands of the hydrocarbons is very striking. We have similar bright maxima of light, succeeded by long drawn-out series of fine lines, decreasing in intensity towards the more refrangible side. This peculiarity, common to both, impels the belief that it is a consequence of a similarity of constitution in the two cases, and that magnesium forms with hydrogen a compound analogous to acetylene. In this connection the very simple relation (2 : 1) between the atomic weights of magnesium and carbon is worthy of note, as well as the power which magnesium has, in common with carbon as it now appears, of combining directly with nitrogen. We may with some reason expect to find a magnesium-nitrogen spectrum. . . .

"The interest attaching to the question of the constitution of comets, especially since the discovery by Huggins that the spectra of various comets are all identical with the hydrocarbon spectrum, naturally leads to some speculation in connection with conclusions to which our experiments point. Provided we admit that materials of the comet contain ready-formed hydrocarbons, and that oxidation may take place, then the acetylene spectrum might be produced at comparatively low temperatures without any trace of the cyanogen spectrum or of metallic lines. If, on the other hand, we assume only the presence of uncombined carbon and hydrogen, we know that the acetylene spectrum can only be produced at a very high temperature, and if nitrogen were also present that we should have the cyanogen spectrum as well. Either, then, the first supposition is the true one, not disproving the presence of nitrogen, or else the atmosphere which the comet meets is hydrogen only, and contains no nitrogen."

[1] Paper read February 12, 1880.

The importance of the question here treated of comes out very well from these two extracts. We find the same spectral phenomenon at once called into court, and very properly called in, both to suggest the existence of chemical substances of which the chemist has never dreamt, and to explain the chemical nature of a large group of celestial bodies.[1]

There is little doubt that when a complete consensus of opinion is arrived at among the workers, other suggestions more far reaching still will be derived from the prosecution of these inquiries. For the present, however, the chief point to bear in mind is that both in line-spectra and in fluted spectra we have indications which I think favour the view that in each case the origin is compound rather than simple.

J. NORMAN LOCKYER

Oban, July 20

THE EDUCATION DEBATE

THE chorus of approval with which Mr. Mundella's report on the progress of elementary education was received on Monday cannot but be gratifying to all who have at heart the highest welfare of the country. With one or two unimportant exceptions—members whose vision is so bizarre as to discern communism in the education of the children of the working classes, and who connect the increase of weeds with the spread of education—what criticism there was referred to details of method. All the members whose opinions are of any weight agreed that vast good had resulted to the country by the working of the Code. As to the special subjects, among which science is included, the weight of opinion was decidedly in favour of their retention. The greatest friends of the Fourth Schedule will admit that there is still much room for improvement in the teaching of these subjects; it cannot be expected that so great a novelty in the system of elementary education in the country can all at once be taught to perfection. About the success of the compulsory system of education it may be said that the House was all but unanimous. The analogy between the treatment of

[1] With special reference to this last question, that of cometary spectra, one of acknowledged difficulty, I may perhaps be permitted to add here by way of note that the view I put forward some years ago touching the relation of this spectrum to that of the nebulæ has been lately strengthened by the observation that at a low temperature one of the brightest lines in the spectrum of iron is that coincident with the chief line in the nebula-spectrum.

paupers and the free education of the children of the working classes will not hold water. In the one case we are simply keeping from starvation people whose improvidence or misfortune have made them a dead burden on their fellows; in the other case we are feeding the minds of those who one day will have to bear the brunt of the work of the nation. The better these future workers are educated, the more intelligently and the more effectively are they likely to do their work, and the less likely are they to become inmates of our workhouses and prisons. As Serjeant Simon testified, even already is there a marked decrease of embryo criminals in our streets. The conclusion come to by Mr. Mundella and those who, like him, have the interests of education at heart, is not that we have gone too far, but that we have not gone far enough; not that we have reached finality, but that we have only made a good beginning. The figures he adduced to prove the success of the existing Education Act were practically admitted to be irrefutable; and we only trust the progress in the next ten years will be at an equal ratio to that achieved during the past decade. "Many of us," he truly said, "would pass away without seeing the full effect of the work we are doing." As to the propriety of encouraging the retention of exceptionally clever boys in elementary schools beyond the regulation age, the figures showed that it would be cruel and unjust to forbid this. Until we have a State system of secondary education in England similar to that about to be sanctioned in Scotland, until an equally decisive step is taken with regard to educational endowments in the one country as in the other, the nation would be doing a gross injustice to force exceptionally clever boys to leave school just when their intellects were beginning to shoot into full vigour. Mr. Mundella showed by his figures that Scotland is still ahead of England in the matter of education; that extra or special subjects are more widely sought after and with greater success, and that a larger percentage of children in elementary schools proceed to secondary education. But it should be remembered that this is the result of many generations of universal education, and that in Scotland it has long been considered as great a disgrace to be uneducated as in England it is considered to be immoral. There among the great majority of the working classes compulsory education was scarcely needed, and this will no doubt be the case in England in the course of a century or so, when education will have become as great a necessity as decent clothing. Again during the debate was it shown by those who have the best means of knowing that where science is properly taught there the children are as a rule more intelligent and bright, and better up in the ordinary subjects than in schools where science is neglected. Sir John Lubbock gave a remarkable instance of the favour with which properly conducted science-teaching is received by the children themselves:—

"He had lately," he said, "visited some of the Lambeth schools, and in one of the last he asked the children which subject they themselves preferred. Out of 229 children in the upper standards, 2 liked grammar best, 11 geography, 31 arithmetic, 38 history, and 147 elementary science. He did not quote this from any wish to exclude the other subjects, but because it seemed conclusive evidence against the proposal to omit elementary science. He knew that many hon. members, when they thought of children learning these extra subjects, pictured to themselves anxious and weary children poring over a difficult and distasteful task. He wished they would go and see the reality—the bright, happy, intelligent faces of the children, and their delight as they found themselves able to answer the questions rapidly asked them by the master."

We have no intention of repeating the arguments we have so often adduced in favour of the teaching of at least such elementary science in our national schools as will be of practical use in after life and help to render the hard lives of the working classes brighter and nobler, and thus elevate the whole nation. The debate on Monday confirms all that has been adduced in favour of such education, and is the best possible reply to the attack of Lord Norton in the Upper House, an attack which the debate showed to be an anachronism. The whole tone of Mr. Mundella's address must convince all but the most prejudiced that the education of the country could not be in better or safer hands, and that he is not in the least likely to take any step that could be considered rash.

Quite in keeping with the tone of his Education address were his remarks in connection with the vote for the Science and Art Department. With regard to the vote of 4,000*l.* for scientific research, Mr. Mundella said that it was expended under the advice of the Committee and members of the Royal Society, and that of the presidents of the various other scientific bodies. He thought the country could well afford to spend 5,000*l.* on the matters that had been alluded to. "As it was we did not spend too much on science and art." This is a remarkable admission to make by our Minister of Science, for such the Vice-President of the Council is in reality if not in name. We do not wish a penny to be deducted from the grant for elementary education, which we hope to see gradually increased; indeed we would strongly urge Mr. Mundella to devote his energies, so long as he has opportunity, to perfecting the teaching of science in our elementary schools. When once a proper system is fairly established, there will be no danger of retrogression —rapid progress will be certain. Not only so, but we are sure that the nation will be convinced that at the other end of the scale the neglect to encourage by national funds scientific research is quite as disastrous to the highest welfare of the country as the neglect of elementary education. In Germany and France the national necessity of both is practically recognised, and they are both amply provided for. If Mr. Mundella is of opinion that we do not spend too much on science, that can only mean that the nation must suffer for this parsimony. It was admittedly as an experiment that the 4,000*l.* was added to the 1,000*l.*, which, by the by, but for the want of faith of the scientific nabobs of the time, might have been 10,000*l.*, and that many years ago. Over and over again have we pointed out the benefit which the nation would reap from research when adequately encouraged, and that we can never hope to hold our own in this matter with foreign countries under existing conditions, under which some of our best men are compelled to waste in exceptional powers in teaching for the sake of bread and butter; while some among the "professors" whom in the view of some we were exclusively to look for research

not only neglect research, but even their students in the most unblushing manner, in their greed of gold. We hope that when next Mr. Mundella has to ask for a vote for the Science and Art Department, he will present as strong a case for the encouragement of advanced science as he has done for the teaching of elementary science. The facts and figures in favour of the one are as strong as those in favour of the other.

EUROPEAN CADDIS-FLIES

A Monographic Revision and Synopsis of the Trichoptera of the European Fauna. By Robert McLachlan, F.R.S., F.L.S., &c. (London: Van Voorst, 1874-1880.)

MOST persons have seen those curious aquatic insects called caddis-worms, which live at the bottom of the water, protected by tubular cases formed of bits of stick, stones, sand, or shells, and are much used as bait by anglers; being, as Izaak Walton remarked, "a choice bait for the chub or chavender, or indeed for any great fish." It is also generally known that these caddis-worms are the larvæ or grubs of winged insects, known as caddis-flies or water-moths, which abound in the vicinity of rivers or ponds and often fly into houses attracted by the light; but few persons except entomologists are aware that there are nearly a hundred and fifty different species in the British Isles, while between four and five hundred are known from various parts of Europe—that they constitute a distinct order of insects, named "Trichoptera," from their hairy wings—and that they possess peculiarities of structure of the greatest interest as serving to connect, however imperfectly, such distinct and highly specialised orders, as the Hymenoptera and the Lepidoptera.

The perfect insects are characterised by four ample membranous wings, of which the hind pair are usually the largest, while the front pair are somewhat more leathery in texture. The wings are always more or less clothed with hair, sometimes to such an extent as to form a dense coat which completely hides the nervures; and it is this peculiar hairy covering which has given the name to the family. The neuration of the wings consists of longitudinal branching veins with a few cross veins forming cells, very different from the netted veins of most of the Neuroptera, with which the Trichoptera were formerly united, but bearing a considerable resemblance to those of some of the smaller moths. The body is also hairy, the legs long and spined, while the antennæ are usually longer than the body, slender and thread-like; and when the insect is in repose these are directed forward, and so closely pressed together as to appear like one. The mouth is very small with quite rudimentary mandibles, and Mr. McLachlan thinks that the insects usually take no nutriment whatever in the perfect state, "existing on the superabundant vitality acquired during their long larval stage," but he adds: "some of the larger species frequent flowers at night after the manner of moths, and are even attracted by the mixtures used by lepidopterists to attract their favourite insects, facts which prove that some, at any rate, partake of liquid nutriment." The exact mode in which this is effected is not yet clearly ascertained.

The eggs are gelatinous, and stick together in a mass which is attached to aquatic plants below the surface of the water, into which the female is said sometimes to enter for the purpose of depositing them in a proper situation. The cases formed by the larvæ are built up of various substances fastened together by silken threads spun from the mouth in the same manner as caterpillars spin their cocoons—another curious point of resemblance to the Lepidoptera. These cases vary greatly in the different families and genera, and though at present very imperfectly known it seems probable that every species has a distinctive form of case. The Phryganeidæ, for example make cylindrical cases of morsels of leaves or fibres arranged in a spiral manner, the cases are open at both ends, and it is believed that the larvæ have the power of turning in them. When about to change into a pupa the larva closes up the ends with vegetable matter and attaches the case to an aquatic plant. They live only in ponds, lakes, or marshes. Another family—the Limnophilidæ—have some genera which live in still, others in running waters, and their cases vary greatly, the most curious being those formed entirely of shells, often taken while their inmates are alive. One genus of this family—Enoicycla—is altogether anomalous, since the female has rudimentary wings and its larva lives in moss, often in woods far away from water, forming a case of fine sand intermixed with vegetable matter. One species is found in England. In the next family—Sericostomatidæ—the larvæ live generally in streams, forming cylindrical cases of sand or small stones, but sometimes the cases are broad and flattened, in others quadrangular, while in one genus—Helicopsyche—they are spiral, formed of sand grains, and often so closely resembling the shells of freshwater molluscs, that some of them have been described as species of Valvata, Paludina, &c.! In the Hydropsychidæ and Rhyacophilidæ the larvæ are carnivorous, and form irregular cases of small stones fixed to larger stones at the bottom of the water, and sometimes several larvæ appear to live in company under a common covering of vegetable and other *débris* fastened together with silk. These are obliged to quit their retreats when wandering about in search of food, and they accordingly have the body and abdomen of a firmer consistency. The Rhyacophilidæ especially frequent torrents. Lastly, the Hydrophilidæ live in more or less seed-like, movable cases, formed of silk with minute sand-grains, and having a slit at each end forming two apertures, from either of which the larva can protrude its head. They are found among water-plants, on the surface of stones at the bottom of streams or ponds, and have the power of spinning a silken thread by which both the case and its inhabitant can float securely in the water. The insects produced from these larvæ are the smallest of the order, and often appear in great numbers.

When the larvæ of Trichoptera are about to change into pupæ they close up the apertures of their cases either with a network of threads or with other materials, and some of them besides spin an inner cocoon. The pupæ, though quite motionless, bear a considerable resemblance to the perfect insect, the antennæ, legs, and wings being fully formed, but shorter, and all inclosed in separate sheaths and arranged on the breast. The head is however armed with a pair of strong horny hooks or jaws

quite different from those of the larva or the rudimentary jaws of the perfect insect. These are to enable the pupa to cut its way through the cocoon and outer case, when it is ready to assume the perfect state. It then becomes active, swimming by means of its two middle legs, the tarsi of which are densely fringed with long ciliæ, forming admirable oars. By means of these the pupa reaches the stem of some aquatic plant, up which it creeps out of the water, and then sheds its pupa-skin, and lives a short aërial life which seems wholly devoted to the duty of continuing the species.

From the foregoing brief sketch of the main features of this order of insects, it will be seen that they form what is probably a very ancient group, which has preserved some of the characteristics of several distinct orders. Though, owing to the structure of the rudimentary mouth, the Trichoptera have to be classed among the mandibulate or gnawing insects, and are supposed to be allied to both the Neuroptera and the lower Hymenoptera, yet in the neuration of the wings, their hairy clothing, the silk-spinning and case-bearing larvæ, and the form and habits of the perfect insect, they more nearly resemble some of the smaller moths, with which Mr. McLachlan believes they have a real affinity. So, in the curious activity of an otherwise quiescent pupa, which possesses special organs for gnawing and for swimming, these insects seem intermediate between the groups with an imperfect and those with a perfect metamorphosis, though far more closely allied to the latter; and owing to these various peculiarities the Trichoptera may be said to constitute a "critical" group, whose study cannot fail to throw light on the affinities and genealogy of insects generally. Owing however to their obscure colours and slightly varied forms they have attracted comparatively little attention, though a few ardent workers have for many years devoted themselves to this branch of entomology; but the appearance of the present elaborate work, which is a model of conscientious labour and research, will form an important era in the study of the group.

This large and handsome octavo volume is devoted to a complete description of all the species of Trichoptera which have been discovered in Europe and Northern Asia, or in what is now termed the Palæarctic Region. These descriptions have all been drawn up from specimens of the insects themselves—often of the greatest rarity—and the fact that the chief museums and private cabinets of Europe and America have placed their collections in Mr. McLachlan's hands for the purposes of this work, is the best proof of the high reputation he has attained as a master in this branch of entomology. The book is illustrated by fifty-nine plates containing about 2,000 distinct figures (all drawn by the author himself), illustrating generic and specific characters mostly derived from the neuration of the wings and the structure of the anal appendages. These latter organs are wonderfully varied from species to species while constant in each; and by carefully delineating them by means of the *camera lucida*, species have been shown to be distinct which appear in all other respects to be identical; and the fact of such distinctness in a considerable number of cases is one of the most curious and interesting results of Mr. McLachlan's researches.

The work has occupied nearly six years in its publication, and it has had the effect of stimulating inquiry to such an extent that a large number of new species have been discovered during its progress, rendering the book half as large again as was anticipated; yet the author believes that a comparatively small portion only of the European species are yet known, while in less familiar regions there is a wide field for the discovery of new and remarkable forms. There remain also a number of larvæ which have not been identified with the perfect insect, and an interesting and useful line of observation is thus open to entomologists both at home and abroad. Under these circumstances every naturalist will appreciate the value of a work which has collected together and thoroughly worked up all the material available to the latest date. Such a book cannot, from its nature, be a popular one. Its production has been a labour of love, and is to that extent its own reward; but the expense of producing such a volume is very great, and in order to encourage and even to render possible the production of such works it becomes the duty of all who wish to advance the study of nature to do what in them lies to relieve such enthusiastic workers from the pecuniary burthen which their self-denying labour brings upon them. If every scientific institution and every Naturalist's Field Club in the kingdom were to purchase a copy of this admirable volume for the use and instruction of their members, they would do much to render the production of such works more common, besides really furthering the progress of research, perhaps even more than by the publication in full of their own Proceedings.

This is undoubtedly the most important British work on Entomology since the completion of Mr. Stainton's "Natural History of the Tineina" thirteen years ago, and it is well worthy of the high reputation of its author; while the clearness of the type, the excellent systematic arrangement, the full indices, and the beautifully engraved figures, are equally commendable. Any detailed criticism on such a book could only be given by a worker in the same group; but as one who has often to refer to natural history volumes for information, the present writer would suggest that the absence of any *family* names as headings to the pages is a great inconvenience, as there is no means of ascertaining what group a genus belongs to or of finding the commencement or end of a family without constantly turning to the index. So far as the typography and general arrangement of the volume are concerned this is the only defect that has been noticed, and that it is so small a one may be taken as an indication of the care and attention which has been bestowed upon the publication, no less than on the composition of this notable volume.

A. R. W.

OUR BOOK SHELF

Ornithological Journal of the Winter of 1878-79; *with Collected Notes regarding its Effects upon Animal Life, including Remarks on the Migration of Birds in the Autumn of* 1878 *and the Spring of* 1879. By John A. Harvie-Brown, F.Z.S., M.B.O.U. (*Proc.* Nat. Hist. Soc., Glasgow, 1879.)

MR. HARVIE-BROWN, well known as one of the most active and practical of our home-ornithologists, has endeavoured to chronicle the abnormal effects of an

unusually severe winter on bird-life. To this end the scattered notices on this subject which have appeared in various journals and periodicals have been collected, and are supplemented by communications from private correspondents and by personal investigations. The result is the memoir now before us, in which the observations thus collected are arranged in a systematic form.

The southern migration in the autumn of 1878 was by all accounts unusually early and rapid. The outer Hebrides appear to have been almost cleared of their smaller birds. Visitors to Tyree in December remarked on the "extraordinary scarcity of common birds," and on the "unusual number of winter visitants." On the Solway Firth also "early notice of the coming winter was afforded by the arrival of vast numbers of wild fowl." Herr Gaetke of Heligoland reports that while in ordinary seasons the autumnal migration in that wonderful island often continues until the end of February, in the autumn of 1878 every migratory bird had sped past by the close of November.

Numerous other testimonies to these facts which are adduced by Mr. Harvie-Brown, leave no doubt as to the general effects produced on bird-life by the unusually severe winter of 1878-79, in which a January "colder than any for forty-one years" followed a December "the coldest of any for twenty-one years." The bulk of the memoir is taken up by a series of notes on the different species systematically arranged, a perusal of which is sufficient to show without doubt that the author's general conclusions are amply borne out by the particulars which he has collected.

On Mining and Mines in Japan. By C. Netto. (Tokio, 1879.)

THE substance of this pamphlet was given as a lecture by the author before the German Natural History and Ethnological Society of Eastern Asia, and it now appears with the above title as vol. ii. of the *Memoirs* of the Science department of the University of Tokio. It is mainly a discussion of the present state of mining and metallurgical industry in Japan, with suggestions for improvements by the introduction of machinery, the establishment of model dressing and reduction works, the formation of private companies, and more particularly the introduction of foreign capital, which is at present prohibited by the Japanese law. These points are treated in some detail, and the moderation with which the author expresses his conclusions shows a practical familiarity with the subject such as is likely to command the confidence of those persons who may be interested in the subject. It is however to be regretted that the author has not been fortunate enough to receive the co-operation of some of his literary colleagues in the production of the work in its present form, as the text, even by the greatest stretch of international courtesy, can scarcely be called English, and the directors of the University must certainly have been unaware of its character when they allowed it to appear among their Records. It is necessary to mention this, as an impression is to some extent current that the translation is of Japanese origin.

The Automatic Multiplier: for Performing Multiplication without Calculation and without Writing down any Figures except the Answer. By John Sawyer (London: George Bell, 1880.)

The Automatic Calculator, for cwts. qrs. lbs. at per lb., Supplying the Cost of any Weight at any Price up to 11s. 11¾d. per lb. By the same.

IN NATURE, vol. xviii. p. 327, we noticed "Automatic Arithmetic" by the same author. We need only endorse the remarks we previously made with regard to the former work, and commend the present admirably compact and handy calculators to practical men who, after a little time spent in getting over the manual difficulty to beginners in manipulating the vertical and horizontal slips, will find these works very serviceable as ready reckoners. Multiplication is reduced to a mere addition of digits: the earlier work facilitated the operation of division as well. We may add that the "Multiplier" is issued in three forms, *i.e.*, for multiplying 4 figures by 4 figures, 6 figures by 4 figures, and, as in the specimen we have, 8 figures by 6 figures.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

The Freshwater Medusa

THE explanation of the discrepancy between Prof. Allman's and my own citation of my article in NATURE, vol. xxii. p. 147, appears to be that Prof. Allman has unfortunately received a copy of NATURE differing from the majority of the issue of that date in the fact that it was printed off before the final corrections, sent to the office of NATURE on Wednesday, had been inserted. These corrections were made before the greater number of the issue was struck off, and I have only just ascertained, to my great surprise, that any of the uncorrected copies had been circulated. The error as to the marginal canal was also present in the proof of my paper, marked "uncorrected proof, confidential," which was circulated among the Fellows at the meeting of the Royal Society on June 17, but the error was corrected by me *before the reading of the paper*.

Accordingly, so far as any *publication* or the public expression of my conclusions is concerned, I have not committed myself to the erroneous notion that the marginal canal is absent, although in the course of my inquiry I did entertain that and many other provisional conceptions as to the structure of Limnocodium.

I shall be glad to see some explanation from the publishers of NATURE of the curious and highly inconvenient phenomenon of dualism in NATURE which has mystified both Prof. Allman and myself. E. RAY LANKESTER

[Premising that we are supposed to leave NATURE in the printer's hands ready for press at 2 p.m. on Wednesday, we have no difficulty in giving the explanation asked for by Prof. Lankester.

His revised proof was received by us on Wednesday morning, June 16, with numerous corrections, which were given effect to. After the paper had been made over to the printer on the afternoon of that day a postcard was received by the printer with an additional correction, which was also duly made. On the morning of Thursday, the 17th, the following note, dated "Wednesday afternoon," was received by the printers after the printing of the American edition had been completed and that of the English one had commenced:—

"DEAR SIR,—If there is time please alter in my diagnosis—
'MARGINAL or RING CANAL *obliterated or much reduced*' into 'MARGINAL or RING CANAL voluminous.'
"Similarly please alter
'RADIATING CANALS terminating cœcally' into 'RADIATING CANALS opening into the marginal canal.'
"Truly yours,
"E. RAY LANKESTER"

Although one-third of the edition had been printed off, the printer, knowing our anxiety to give contributors every facility for corrections, stopped the press, and made the alterations which were asked for "if there is time." Possibly Prof. Lankester has no idea of what is involved in stopping a steam press. However this may be, the press was stopped in order to carry out to our utmost what we considered to be Prof. Lankester's wishes, and we are astonished that he can have put any other interpretation upon what happened. Prof. Lankester's letter given above is undated, but it was received on July 31 at mid-day. On the 28th he wrote, stating that he had found there were "two issues of NATURE of June 17," and requesting us to "state this if necessary." This does not

seem to accord well with the statement above (July 31) that he had only "just ascertained" the fact to his "great surprise."
—ED.]

Subterranean Kaolinisation

A YEAR ago Mr. John Arthur Phillips, in criticising, before the Geological Society, my theory of kaolinisation as a source of superficial rock temperatures, made a point which is interesting in its bearing upon the composition of derived or secondary lithological products. He endeavoured to ascertain the number of tons of felspathic rock that must be yearly kaolinised in order to supply the quantity of alkalies known to be contained in the mine waters of the Comstock silver lode in Nevada, and in doing so he began with the supposition that in the process of kaolinisation *all* of the alkali in the felspar goes into solution and is removed. This assumption is undoubtedly incorrect, for even the surface clays which are deposited from running water, and therefore must have been subjected to a maximum leaching, almost invariably contain potassic and sodic salts, as any one may learn by studying the subject of fireclays.

But when the clay is formed by the alteration of rock at great depths, beyond the line of ready drainage and in the presence of a minimum quantity of water, the product is, or may be, quite different from the clay of sedimentary deposition. It is in fact merely the original rock hydrated, and from the example given in the Comstock region the alteration product does not seem to lose much, if any, of its original alkalies. This is demonstrated by the analyses given in Mr. King's Report on the Fortieth Parallel. All the existing analyses of the clays in this region were made on specimens obtained in the first thousand feet of depth, and most of them were taken within 500 feet of the surface. That is, they all come from the region of active drainage, the oxidising and other effects of atmospheric action being well marked in this lode down to the depth of 600 feet. The mean of four analyses of clays shows 4·72 of alkalies and 10·86 of water, CO_2 and P_2O_5. One of the specimens has been very strongly altered, having lost about 10 per cent of silica, while another seems to have gained about half as much of the same constituent. As to the composition of the original rocks (propylite and andesite,) it is impossible to be exact, for the alteration in the region has been so extensive and thorough that all attempts to obtain an unaltered specimen have failed. The least altered specimen of propylite from the Virginia range of mountains in which this lode is found contains 5·08 per cent. of alkalies, with 1·02 loss by ignition. The most altered specimen contained 5·26 per cent. of alkalies, and 6·53 loss by ignition. Andesite showed in the least altered specimen 4·7 alkalies and 2·8 loss; in the most altered specimen 7·37 alkalies and 4·35 loss. It is impossible to compare the clays of this district with unaltered rock from other localities, for the reason that the composition of these eruptive rocks varies strongly, especially in the percentage of alkalies. On the whole I think that any one who will compare the tables of analysis given in vols. i. and iii. of Mr. King's work will be convinced of the truth of what I have asserted above—that subterranean kaolinisation is merely the hydration of a rock in place without other serious alteration. The fact has importance in its relation to the origin of some hydrated aluminous rocks.

Mr. Phillips calculates that the average proportion of alkalies in these rocks is 6·4 per cent., that 813 tons of alkalies are removed yearly in the mine waters, and that "it consequently follows" that the felspar in 12,703 tons of rock "must be annually kaolinised, and the whole of the alkalies removed in solution." It seems to me that a metallurgist of Mr. Phillips' experience should have known that the alkalies are never completely removed in kaolinisation. That he is not acquainted with the peculiar and remarkable conditions of the Comstock is not surprising, for the lode receives but little attention, and that of the most hasty kind, from visitors. I ask your permission to add the following summary of facts which rebut Mr. Phillips' criticism:—

1. The removal of alkalies in subterranean kaolinisation, if it is judged by the existing incomplete series of analyses, seems to vary from less than one-fifth of the quantity of alkalies in the present rock down to almost nothing.

2. The whole results of kaolinisation are not represented in the mine waters. In the vast areas of dry rock alteration has been extensive, and seems to be going on now by means of water-vapour, and none of this action supplies alkalies to the mine waters.

3. The liberation of hot gas which is an accompaniment of kaolinisation by atmospheric waters conveys the heat produced in the dry areas to all parts of the mass, and especially to such channels as watercourses and mine-openings.

4. Kaolinisation in the Comstock region is not produced by the action of cold water on cold rock, but by the combination of water and rock, both already heated before the action to very nearly the temperature they attain after it. The heat of the rock is cumulative, its present temperature being mainly the result of ages of previous kaolinisation, the heating effects of which were preserved from dissipation by a blanket of rock 1,000 feet thick. The water which takes part in the action at existing depths of the mine has been heated by its percolation through 1,000 to 1,500 feet of hot rock lying below the blanket spoken of. Mr. Phillips calculates that 85° are added to the temperature, but in fact the actual increment of temperature by kaolinisation is, in the locality given, but a small fraction of this quantity. Considering the small rainfall of Nevada, and the depth at which the waters are now drawn from the rocks, and the perfect correspondence of depth and temperature, it is more probable that the actual gain of heat does not exceed one or two degrees, and may even be less.

5. Mr. Phillips' calculation that 330 tons of water are heated by the kaolinisation of one ton of rock has no foundation in the known facts, but is probably more than 99 per cent. from the truth. His further error in supposing that the increment of heat is 85° F. instead of being in the neighbourhood of 1°, as is more probable, relieves his criticism of whatever weight it might have if it had been adjusted to the well-known facts of the case.

115, Broadway, New York, June 17 JOHN A. CHURCH

"On a Mode of Explaining the Transverse Vibrations of Light"

I VENTURE to call attention to what appears to me to be (possibly) an objection to the views advanced by Mr. S. Tolver Preston in his interesting article, "On a Mode of Explaining the Transverse Vibrations of Light" (NATURE, vol. xxi. p. 256). Mr. Preston's hypothesis I understand to be a special modification of Lesage's, the speciality being that the corpuscles which by their impact on the cage-atoms of ordinary matter cause gravitation, are also the carriers of some vector property, the changes in which constitute radiant energy, and that in fact there is no ether except just this assemblage of minute corpuscles co-existing in the ultra-gaseous state (*i.e.*, with a mean free path of great length). Now, as far as I can see, it is a strict corollary from this exceedingly fascinating hypothesis that the velocity of propagation of gravity must be identical with that of light. In other words, the acceleration of a material particle at any instant (I) caused by the attraction of a second particle must be directed to the spot occupied by that second particle, not at the instant I, but at some instant prior to I, the interval between the two instants being the time taken by the ultramundane corpuscles, and therefore by light, to travel from the one particle to the other. But do not the observed planetary motions necessitate the assumption that gravity, even if propagated in time at all, is propagated with a velocity vastly in excess of that of light? At any rate this statement is frequently met with in discussions on the nature of gravity, and is much prized by advocates of "action at a distance." If it is true, does it not constitute a fatal objection to Mr. Preston's hypothesis?

Some two years ago it occurred to me that the ether might consist of particles in the ultra-gaseous state, and might thus, in accordance with Lesage's hypothesis, give rise to the mutual gravitation of the grosser atoms immersed in it. I was then unaware of the late Prof. Clerk Maxwell's suggestion that these particles, by being the carriers of some vector property undergoing periodic reversal, might account for the propagation of light; and vaguely hoped that it might receive some explanation from the fact, also discovered by Clerk Maxwell, that a body in the ultra-gaseous state behaves like a solid towards any confining boundaries to the extent that, like a solid, it opposes a certain resistance to change of shape. But I deemed the whole theory to labour under the fatal objection of not giving a sufficient velocity of propagation to gravity.

I write in the hope that Mr. Preston or another of your readers will inform me whether my objection is a valid one.

J. W. FRANKLAND

Registrar-General's Office, Wellington, New Zealand, May 6

Expansion of Glass by Heat

THE reproduction in your "Physical Notes" (NATURE, vol. xxii. p. 157) of Mr. R. H. Ridout's neat experiment for illustrating the "Expansion of Glass by Heat" (*Phil. Mag.* for June, 1880), recalls to mind an equally striking method of exhibiting this property of glass to a class of students in physics. Select a straight glass tube 50 or 60 centimetres in length and 1 or 2 centimetres in diameter. Place it transversely in front of a fire, in a horizontal position, properly supported near its two *ends* on two horizontally-adjusted rods of hard smooth wood of about the same diameter as the tube; the glass tube will gradually *roll towards the fire.* Now let the supporting rods be transferred to either side of the centre of the tube, so as to support it near its *middle;* the tube will now gradually *roll from the fire.*

It is scarcely necessary to remind the reader that the greater dilatation of the glass on the side of the tube which is nearer the fire renders it *curved*, with the convexity next to the source of heat, so that, when supported near the *ends*, the *falling* of the *central parts* of the curved tube rolls it *towards* the fire; but when supported near the *middle* the *falling* of the *ends* of the similarly curved tube rolls it *from* the fire. These experiments, it is evident, succeed better when the *cold* tube is first adjusted near the fire than when it has been so long exposed to the action of the heat as to have become heated throughout its mass.

It seems that about the year 1740 this behaviour of glass tubes under similar conditions was noticed by Mr. C. Orme, of Ashby de la Zouch, while heating some barometer tubes. The Rev. Granville Wheler, who carefully verified the experiments of Mr. Orme, very correctly ascribes the phenomena to the *distortion* of the tube due to the action of heat (*vide Phil. Trans.*, No. 476; also *Edinburgh Encyclopædia*, 1st Am. ed., 1832, vol. ix., article "Glass," p. 773). Nevertheless in the United States this behaviour of glass tubes, when placed before a fire, has been frequently classed among the *unexplained mysteries of glass!* As recently as 1865 Mr. Deming Jarves, of Boston, in his little volume entitled "Reminiscences of Glass-Making," p. 10 (2nd ed., N.Y., 1865), refers to the phenomena, but with not one word of *explanation*. In fact not long ago some of our semi-scientific journals characterised these phenomena as *mysterious* and *inexplicable*. Hence I have for the last twenty or thirty years employed such experiments, not only as exhibiting *visible* manifestations of the expansion of glass, but also as affording an *instructive and significant illustration of how completely the most obvious mechanical results may be overlooked or obscured under the inspiration of the propensity to seek for the marvellous in nature!* JOHN LECONTE

Berkeley, California, July 8

Fascination in Man

HAVING frequently seen it stated in popular works on natural history as well as in some books of travels (chiefly Australian) that certain snakes possessed the power of so fascinating, with their gaze, birds and other creatures as to be able to seize upon and devour them without any difficulty, I am induced to inquire if such a power is peculiar to the serpent tribe or not, and incidentally to ask if any instances of its influence or extension can be traced, up the scale of creation, to man himself. Being of opinion that such is the case, while it has occurred to me that many of the fatal accidents that occur in the streets of large cities, such as London, &c., might be ascribed to some such agency or sensation, I am induced to call attention to the circumstance in these pages, and to submit the following as my own personal contributions towards the inquiry:—

Describing certain incidents of the siege of Gibraltar, Drinkwater says, "History," p. 75, that "on the 9th Lieut. Lowe . . . lost his leg by a shot on the slope of the hill under the castle," and the italics are mine throughout. "He saw the shot before the fatal effect, *but was fascinated to the spot.* This sudden arrest of the faculties was not uncommon. *Several instances occurred to my own observation where men totally free have had their senses so engaged by a shell in its descent that, though sensible of their danger, even so far as to cry for assistance, they have been immediately fixed to the place.* But what is more remarkable, these men have so instantaneously recovered themselves on its fall to the ground as to remove to a place of safety before the shell burst."

Alluding to the first casualty that occurred at Cawnpore during the siege of the entrenchment there in 1857, Mowbray Thomson says ("The Story of Cawnpore," p. 66) that "several of us saw the ball bounding towards us, and he (McGuire) evidently saw it, but, *like many others whom I saw fall at different times,* he seemed fascinated to the spot"; and an old and now deceased departmental friend, who went through the whole Crimean campaign, assured me that he was once transfixed (fascinated, he called it) after this fashion in presence of a shell that he saw issuing from Sebastopol, and whose every gyration in the air he could count. Other military friends have discussed the point with me in this same wise, and I think there is some allusion to it in one or other of the works of Larry, Guthrie, Ballingall, or others of that ilk. W. CURRAN

Warrington

Monkeys in the West Indies

IN consequence of my removal from the West Indies to the West Coast of Africa, and of illness since my arrival here, I have not until now had time to read in the back numbers of NATURE the controversy on the subject of "Monkeys in the West Indies," which, it may be said, I created by my communication in NATURE, vol. xxi. p. 131. I trust, therefore, I now may be permitted to reappear on the scene and to sum up my case.

In my communication I quoted, from Prof. Mivart's lecture on "Tails," an extract which appeared in your columns (NATURE, vol. xx. p. 510), viz.: "Monkeys are scattered over almost all the warmest parts of the earth save the West Indies, Madagascar, New Guinea, and Australia," and I added, with the utmost respect for Prof. Mivart, that the above statement was not "quite correct," adducing as proof the fact that they were found in St. Kitts, Nevis, and Trinidad. Mr. Sclater, F.R.S., the distinguished zoologist, answered my letter (NATURE, vol. xxi. p. 153), explaining that Prof. Mivart was correct in his statement; that the monkeys of St. Kitts were not "indigenous" to that island, and that Trinidad originally was part of the mainland of South America. Mr. Sclater said nothing about the Nevis monkey. Dr. Imray of Dominica followed with a quotation from Père Labat (NATURE, vol. xxi. p. 371), and as regards St. Kitts and Trinidad, the monkey question was closed.

But it subsequently came to my knowledge, through hearsay evidence, that monkeys existed in large numbers in Grenada, one of the Windward group of islands, although travellers and historians from the time of Père du Tertre to that of Bryan Edwards seemed to be ignorant of the fact. As I had left the West Indies when I obtained this information, I at once called Dr. Imray's attention to it, begging him to ascertain its accuracy and then to communicate with NATURE. Dr. Imray has done so (NATURE, vol. xxii. p. 77), and, by a curious coincidence, his letter appears in the same number in which a Grenada correspondent, signing himself D. G. G., charges me with being "quite as much in error as Prof. Mivart," and makes me say that "*the only islands* in the West Indies *where monkeys are to be found are St. Christopher* [*i.e.*, St. Kitts] *and Nevis.*" The italics are my own, but I think D. G. G. should at least be careful to quote accurately.

I have no wish to trespass further on your valuable space. What I desired to show and what I have shown is that monkeys *do* exist in many of the West India Islands, and that, although nearly four hundred years have passed away since the discovery of the islands, their natural history is still very imperfectly known. And yet these islands are within easy steaming distance from England; they are inhabited by people whose kindness and hospitality to visitors are proverbial. Their mountains afford all the varieties of healthy climate, and for the botanist, the geologist, the entomologist, and the man of science generally, there are few, if any, richer fields of instruction and enjoyment.

Government House, Cape Coast Castle, EDMUND WATT
Gold Coast, July 3

Utricularia

CAN any of the readers of NATURE inform me whether the sharp clicking noises produced on removing Utriculariæ from the water (particularly for the first time) have been noticed or described? I have not succeeded in determining the species, as the plants are not yet in flower. J. W. CLARK

R.I.E. College, Cooper's Hill, July 30

The British Association and Provincial Scientific Societies

THE list of delegates of provincial scientific societies prefixed to the list of members attending the annual meeting of the British Association having appeared to me to be practically useless, being in reality merely a list of "temporary members" of the general committee—with the object of making it of some value to the societies represented, and also eventually to the Association, I suggested, at the meeting at Bradford last year, an alteration in the rule of the Association which affects this list of delegates. My suggestion being favourably received by the Council, the alteration proposed was adopted at a meeting of the General Committee.

The effect of this alteration is to admit as a temporary member of the Committee the *secretary* of any scientific society publishing *Transactions* as well as the president, or in his absence a delegate representing him. My object in proposing it was, as I then stated, to admit of a meeting or conference of the presidents and secretaries of societies thus represented being convened under the auspices of the Association, at which matters concerning such societies (their management more especially) might be talked over and arranged, &c., a thing which could not be attempted in the absence of the secretaries, they, as a rule, having almost the entire management of their societies.

As the revised rule first comes into operation at the approaching meeting of the Association at Swansea, I should be glad if you will draw attention to it, either by the insertion of this letter or in any other way. JOHN HOPKINSON

Hon. Sec. Herts. Nat. Hist. Soc.

Wansford House, Watford, July 24

Intellect in Brutes

THE following story was told me by the mistress of the dog herself. The event occurred in a small village in Essex, some years ago.

"A little black and white King Charles, beloved by its mistress, but not by its master, was one day lying on a rug in the drawing-room when the master came in, having just paid its tax. He said: 'I have just paid that dog's tax'; and looking at it with a severe expression added: 'and he's *not worth* his tax." The little dog immediately got up, and with a crestfallen appearance put its tail between its legs and left the room. It was never seen afterwards, nor was it ever heard of again, although inquiries were made at the time in every direction."

GEORGE HENSLOW

Chipped Flints

A FEW days ago a man who had been cutting turf in this neighbourhood came to tell me that he found a quantity of small flints at the bottom of the "bog-hole," and he brought some of them for my inspection. Seeing that they all bore very obvious marks of handicraft, while a few were more or less rudely shaped like arrow-heads, I immediately went to the place, accompanied by the man, and succeeded in getting a number of specimens, of which some fifty or sixty show pretty plainly the design of the workman. Among them are a few white flints, evidently from the Chalk, and indeed with some chalk attached to them. This is worthy of remark, as there is no chalk nearer than the North of Ireland, nor are there any chalk flints among the boulders here, where the drift was unmistakably derived from the limestone, silurian, mica slate, and syenite rocks of the west and south-west. The other flints are black, like the chert, which occurs plentifully enough in the carboniferous lower limestone formation of the district. Several pieces of charcoal were mixed with the flints, showing probably that fire was used in breaking them up in the first instance. The final operation of chipping seems to have been done with a very delicately-pointed instrument, not thicker than a large sewing-needle. Its marks, both where it struck off the chip and where it failed to do so, are as plain and fresh-looking as if they were made quite recently. It must have been used as a punch and worked with a hammer, and there must have been some contrivance like a vice to hold the flint during the operation. It is really hard to think that the instrument with a point at once so minute and powerful could be other than metallic; but then, if there was metal available, why have recourse to flint? Perhaps these flints might be referred to a time late in the neolithic period, during the transition from stone to metal, when the latter, being scarce, was used only for tools. At one time I fancied that I made a capital discovery of metallic particles struck off and lodged in the stone, but with a pocket lens they were found to be only specks of pyrites. A small sandstone slab, quite smooth on one side, lay among the flints, but it was either taken away or thrown into one of the turf holes filled with water before I came to the place, and I failed to find it. By its impression in the turf which remained untouched it appeared that one surface was quite polished. The other was described as rough. Whether it was used in the manufacture of the arrow-heads or not I cannot surmise. The shape of a large sandstone pebble that I found might suggest its use as a hammer, but it showed no signs of abrasion. At one time there must have been at least twelve feet of turf over the flints. They lay immediately above the roots of a pine close to a short piece of the stem that remained. The tree was most probably growing when the flints were worked, and it may be of some interest to note that the craftsman selected the shade or solitude of a wood for his *atelier*.

In this bog is found the striking phenomenon of two growths of trees, one overlying the other. The lower was chiefly pine, identical with, or nearly allied to, the *P. sylvestris*, and rooted in the drift clay or gravel. The upper trees were principally oak, and grew in the turf formed from the prostrate wood that preceded them. This is remarkable, showing a wide difference in the habitats of both kinds and those of their representatives of the present day, when we find the oak growing in clayey soils, while in general the moor agrees well with the firs and pines.

J. BIRMINGHAM

Milbrook, Tuam, July 12

Lunar Rainbows

THE following communication has been forwarded to me by a lady of considerable ability, and can be relied upon. As a lunar rainbow is a rare phenomenon, perhaps you may deem the notice worthy of a place in NATURE. J. KING WATTS

St. Ives, Hunts., July 30

"On July 19 a most brilliant lunar rainbow was visible in this village of Over, Cambridgeshire, and was observed by other persons as well as by myself. For several days previously there had been a succession of violent storms, with much thunder and lightning, and the falling of vast quantities of rain. The whole atmosphere was evidently in a very perturbed condition, with considerable electrical disturbance. The wind had for several days previously been exceedingly variable, veering from point to point with rapidity, and on the day in question it had veered much from one point to another. At 10 p.m. the wind blew strong and steadily from the south-west, thereby driving the great masses of cloud to the north-east. To the front of the position I was in, the clouds had been pushed or rolled up into a dark mass extending from the north, north-east, east, and nearly to the south-east, up to the zenith, so that one portion of the horizon was cloudless and the other portion black and sombre. The moon was very clear and nearly to the full. The sky had a singular appearance, one part being most brilliant and clear, and the moon riding in it free from every particle of cloud, and the other part to the north-east was most intensely dark. At 10.35 a beautiful and brilliant silvery white arch was formed (north-east), extending nearly from the zenith down to the horizon. The arch was most perfect in all respects. The force of the wind had abated. There were no prismatic colours visible, but the whole arch, standing out, as it were, in bold relief on the black cloud, had a most awe-like but beautiful appearance, and the sight can never be forgotten. The singular phenomenon was brilliantly visible for a considerable length of time, thereby clearly indicating the slow progress at which the shower was then moving onward. Such a phenomenon is very seldom to be seen. The sky continued clear during the remainder of the night. "ANNE GIFFORD

"Over, Camb."

W. E. WILLINK.—The "substance" you send us is a well-known alga, *Nostoc commune*. See the "Treasury of Botany," *sub voce* Nostoc.

BRICKMAKING.—A "Brickmaker" asks if any of our readers can tell him of a book on Brickmaking which gives good and trustworthy information about the operations, machines, &c. He has a book by E. Dobson, but it is thirty years old, and therefore of very little use.

CARBON AND CARBON-COMPOUNDS

THE wayward and inconstant train of coloured light-bands that spectroscopists have noted and distinguished in the spectra of various carbon-compounds in flames and gas-vacuum tubes are as yet far from having all received their full and appropriate interpretations. The extent to which they abound as impurities in almost all spectral vacuum-tubes is a common observation, and in a survey of this kind, aiming at no systematic exploration, of a variety of end-on vacuum-tubes in the large and perfect spectroscope erected by Prof. Piazzi Smyth for the examination of auroræ, I have had from time to time, at his kind invitation, excellent opportunities for discriminating some of the component groups and clusters of the carbon-denoting series from each other pretty clearly.

Among the least alterable and changeful in its appearance of these coloured ranks is the five-tongued spectrum of wedge-like bands best seen in the end-on prismatic view of a coal-gas blow-pipe flame. Its bands have shaft-lines at the edge and on their fading slopes, with the exception of the last or violet one, just including within its bright edge the solar line of Fraunhofer's spectrum, G. This has a fine-line precursor, nearly coincident with $H\gamma$, and a faint haze-band preceding it. Close to the place of b_1 in the solar spectrum appears the bright edge or chief shaft-line of the green band, fitly styled the "green giant," as it is the real Anak of the coal-gas flame-spectrum. Its less refrangible similitudes in the yellow-green and orange-red are quite subordinate groups, the latter being only discernible in spectroscopes of large aperture and of very great transparency. The fifth finger of this spectral gauntlet is a blue band, or quintett of five close lines pretty equally spaced and pretty equal in brightness, with little haze between them, lying once or twice its own breadth on the more refrangible side from $H\beta$ (F.). The frontispiece of Watt's "Index of Spectra" contains a figure of this spectrum; and wave-length positions and symbols and descriptions of its groups are given in the body of the work, under the title "Carbon, Spectrum I." α, γ, δ, ϵ, f (β and η *carent*) are the five familiar potentates of the blow-pipe flame; but the two line-bands ζ, θ, one on each side of f, added in the figure and in the text of Watt's "carbon-spectrum I.," are not visible in the blow-pipe flame-spectrum. Along with a similar ultra-violet cluster just following H K in the solar spectrum, they form a triumvirate, the spectral origin of which Professors Liveing and Dewar have recently affirmed to be cyanogen. A reason to question the correctness, however, of Messrs. Liveing's and Dewar's surmise presented itself to me in my examination of the end-on tubes by the spectacle of the six-lined violet cluster θ rearing itself, without any accompaniment of its blue associate ζ, into extraordinary magnificence in a Marsh-gas tube. The grey or ultra-violet member of the trio was indeed weakly discernible at the same time; and in just this relative brightness and condition of extreme isolation from every other spectral feature I have recently observed these two violet and ultra-violet line-clusters in the blue flame part of the arc between particularly pure carbon poles in the Brush's or Anglo-American Company's electric light.

Another reason for suspecting multiplicity of form in the carbon-spectrum by itself occurred to me in an examination of the spectrum of cyanogen in an end-on tube. A perfect counterpart, it is well known, of the blow-pipe flame spectrum is producible by the induction-spark in vacuum-tubes of olefiant gas. Accompanying it however is another spectrum which in its fullest purity and intensity is equally well known to be produced by a weak induction-spark in tubes of carbonic oxide and carbonic acid gas. The blue quintett and the violet G-band are wanting in this spectrum. The edges of the green, citron and orange-red bands are displaced, and these bands are devoid of shaft-lines, being composed entirely of haze and fine linelets which smoothly shade them off. The olefiant gas and "carbonic oxide" spectra mingle together, usually in divers proportions in the carbon-impurities of gas-vacuum tubes.

Two cyanogen tubes (one of them of hardest glass) prepared by M. Salleron betrayed alike only the smallest trace of hydrogen by its red line, when they were lighted up by the induction-coil. Aqueous and atmospheric oxygen may therefore be presumed to have been pretty completely expurgated from these tubes, and the gas which charged them to have been an exceptionally pure compound of nitrogen and carbon. Far brighter, notwithstanding this, than in any other vacuum-tube, the smooth-shaded "carbon-oxide" bands made their appearance; and equally splendid with them was the close-ribbed red and yellow fluting forming the less-refrangible part of the spectrum, figured and described by Ångström and Thalèn as that of "nitric oxide." The coincidence with the same spectrum of the bright cyanogen-tube lines in the blue and violet spectral regions was not closely examined; but as far surpassing in brightness the red-end view of it obtained in any other nitrogen-holding vacuum-tube (nitric oxide itself not excepted), the rasp-like ridges of the so-called nitric oxide spectrum were immediately measured with great care and accuracy. Ångström's positions and *tableau* (exactly reproducing that of Plücker and Hittorf) of this region were completely verified; and the discussion of the well-based determinations left no doubt that while a simple order reigns sensibly among the small linelet features of each separate ridge, the ridges have no perceptible connection with each other or with the linelet-intervals upon them in the pitch of their wave-frequencies, although they follow each other closely in a gradually narrowing succession. In the rest of the nitrogen-spectrum, where the ridge-intervals are much wider, it is again not possible to trace between the ridges any simple wave-period connection.

Were I not from these measures, and from the foregoing considerations disposed to regard shaded spectral bands as independent systems of vibration, indicating most probably particular atomic groupings in a molecule, I should have beheld with some surprise the complete and thorough metamorphosis shown me by Mr. Lockyer since the above particulars were noted, which the smooth-banded "carbon-oxide" spectrum undergoes by introducing a condensing-jar, or better, a jar and air-break, into the circuit of the induction-coil. The smooth shadings disappear, the shaft-lines, the "Anak and the sons of Anak" of the olefiant-gas or blowpipe-flame spectrum make their appearance in their place; even the blue quintett of that spectrum comes forth from its hiding-place; and, as far as I could examine the spectral appearance of the carbonic-oxide tube in the now condensed discharge with complete precision, the whole blow-pipe flame, or so-called "hydro-carbon" spectrum, is perfectly reproduced. If we cannot admit, as I think that the cyanogen-tube experiment forbids us to do, that a chemical transformation has taken place, then we must acknowledge that among the forms which the spectrum of carbon is capable of assuming, there may, by subdivision of its molecule into separate vibrating systems, exist not one, but as many different "low-temperature" spectra of that Briareus-like, hundred-fisted, or Proteus-like, hundred-visaged element, as the electric discharge is capable of dividing its evidently complex gaseous molecule into separate spectroscopically individual groups. A. S. HERSCHEL

PHYSICS WITHOUT APPARATUS

I.

IT is almost a proverb in science that some of the greatest discoveries have been made by the most simple means. It is equally true that almost all the

more important facts and laws of the physical sciences can be illustrated and explained by the help of experiments made without special or expensive apparatus, and requiring only the familiar objects of common life for their performance. The greatest exponents of popular science—and amongst them notably Faraday—delighted in impromptu devices of this kind. It is indeed surprising how throughout the whole range of natural philosophy the hand of the master can turn to account the very simplest and rudest of apparatus. A silver spoon, a pair of spectacle lenses, a tumbler of water, and a few sheets of paper suffice to illustrate half the laws of geometrical optics. A few pieces of sealing-wax, some flannel, silk, writing paper, pins, and glass tumblers will carry the clever experimenter a long way into the phenomena of electricity. These are things which any person can procure, and which any person can be taught to use. But their right use depends on the possession of accurate scientific knowledge and a clear understanding of *what* the various experiments are to prove. In fact the art of experiment and the science of inductive reasoning are the essential qualifications necessary to make *Physics without apparatus* profitable.

The short series of papers which it is now proposed to publish in NATURE under the title of *Physics without apparatus* will deal with some of the more important and interesting of these simple matters of experiment. The subject of them has been more immediately suggested by the publication in our contemporary, *La Nature*, of a kindred series of articles by Mons. G. Tissandier, from which a number of the illustrations we present to our readers are taken. The matter of the present series is however new.

Amongst the simple mechanical laws with which a beginner in physics must acquaint himself is that commonly referred to as the *law of inertia*, which is, however,

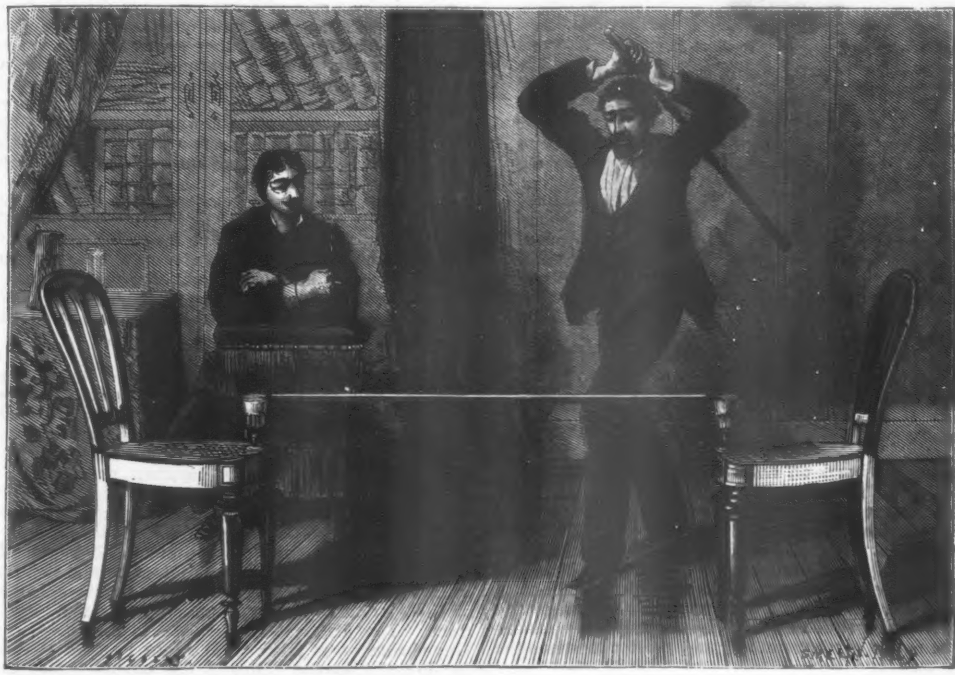

FIG. 1.

very often so imperfectly expressed as to be misapprehended. It requires force to move matter, not because matter is inherently lazy or sluggish, but because it possesses *mass*. The greater the mass of matter in a ball, the harder work is it to send it rolling. Force is also required to stop matter that is moving, the reason again being that a mass moving under the impulse of an impressed force possesses a certain moving energy which cannot be at once reduced to nothing. In either case—either to move a mass or to alter the motion of a mass—force must be employed and energy expended. Of this law of inertia many examples might be given: and there are many curious facts which this law serves to explain. Some of the most striking of these are those in which the effect of sudden forces is different from that which might have been expected. In Fig. 1 we give an illustration of an experiment of this nature. A wooden rod—say a broomstick—has a couple of needles fixed into its ends, and it is then supported upon two wine-glasses resting upon two chairs. If a heavy poker is now brought down very violently upon the middle of the stick it will break in two without the needles or the glasses being broken. A feeble or indecisive blow will fail to do this, and will break the glasses or the needles, or both. Here the moving energy of the heavy mass, the poker, is suddenly transferred to the middle of the stick, so suddenly that it is broken asunder before the thrust has *time* to reach the fragile supports.

Another simple experiment on inertia is equally instructive. Lay any ordinary visiting-card upon the knuckle, or upon the top of an inkstand or other convenient support. On the card place a brass weight, or a spool of thread, or any other small heavy object. Now flip away the card with the finger and thumb; it will fly out, leaving the heavy object where it was. In the same way if a dozen draughtmen are piled up one upon another

in a column, the lowest one can be removed without making those above it fall, by hitting it aside with a very rapid stroke with a table-knife. Here again a feeble stroke will fail.

Our second figure illustrates inertia in another way. A heavy metal ball is hung by a thread to the ceiling or to a shelf, and another thread is attached below. Tug at the lower thread, and it will break. If the tug be slow the ball will come down too; but if the tug be sharp and fierce

FIG. 2.

the thread will break off *below* the ball, breaking, in fact, before the pull has time to impart to the mass of the heavy ball a sufficient moving energy to enable it to rupture the string by which it hangs.

Many other illustrations of a similar kind might be narrated. Of these probably the most telling is that of firing a tallow candle from a gun through a deal board, in which it leaves merely a hole, as the writer can testify from several repetitions. Here, however, we are passing into the region of "apparatus," and must not pursue the matter further.

COUNT POURTALES

"IN the death of Louis François de Pourtales science has met a heavy loss. He was the Swiss representative of an old family, which had branches also in France, Prussia, and Bohemia. Trained as an engineer, he emigrated in early manhood to the United States at nearly the same time as the late Prof. Agassiz, to whom he was much attached, and whose pupil and fellow-worker he was. He entered the Government service in the department of the Coast Survey, and continued in it many years. His talents and industry made him a man of mark, to whom was intrusted much work that required original thought. Especially did he show interest in the problems of deep-sea soundings and the structure of the ocean bottom, an interest that led to profound observations on the physical geography of the Carribean Sea and the Gulf Stream. His papers on this subject were of the first order, and established his reputation in Europe as well as in America.

"By the death of his father he succeeded to the title, and received a fortune which enabled him to devote himself wholly to his favourite studies, and to do much in continuing the great work of Louis Agassiz. Appointed keeper of the Museum of Comparative Zoology, he gave himself, with untiring devotion, to carrying out the arrangement so laboriously planned by his friend and master. Dividing the task with the curator, Alexander Agassiz, he pushed forward his part of the work with the easy power of a strong and highly-trained intellect. Every day and all day at his post—now pursuing special investigations, and now directing the details of the museum—he was the model of an administrative officer.

"He had not an enemy, and could not have had one; for, although firm and persevering in temper, he possessed the gentleness of a child and a woman's kindness. His modesty amounted almost to a fault; and people wondered why a man who was master of three languages should talk so little. But with intimate friends he would speak freely, and never without giving information and amusement. His range of learning was very wide, and his command of it perfect; nor was it confined to mathematics, physics, and zoology. He did not scorn novels and light poetry, and was knowing in family anecdotes and local history. Indeed, it was a saying in the Museum that if Count Pourtales did not know a thing it was useless to ask any one else.

"His strong frame and temperate mode of life gave hope of a long period of usefulness, for he was only fifty-seven, and in the prime of his powers. But it was not to be. Stricken, without apparent cause, by an obscure internal disease, he succumbed, after some weeks of suffering heroically endured. In seven short years he has followed Louis Agassiz, and there seems no hand to take up his burden."

The above account of Count Pourtales appears in the *Boston Daily Advertiser* of April 20, and is, we believe, from the pen of Prof. Theodore Lyman. We would here, in addition, refer briefly to some of Count Pourtales' scientific work. Almost from the commencement of his connection with the United States Coast Survey he deeply interested himself in deep-sea questions, and some of the earliest observations on the nature of the deep sea bottom and of Globigerina mud were made by him. He wrote on the structure of Globigerina and Orbulina, and described the occurrence of the small Globigerina-like shells bearing spines in the interior of certain Orbulinæ, which he concluded were the swollen terminal chambers of Globigerinæ containing young in progress of development. The first step in deep-sea investigation in the United States was taken by the late Prof. H. D. Bache on his assuming the duties of the United States Coast Survey in 1844, when he ordered the preservation of specimens brought up by the lead. Every specimen was carefully preserved and labelled, and deposited in the Coast Survey Office in Washington. The microscopical examination of the specimens was commenced by the late Prof. J. W. Bailey, and after his death this work passed into the hands of Pourtales, who devoted his time to it in the intervals of other duties. That most important deposit, Globigerina mud, was first discovered by Lieutenants Craven and Maffit, U.S.N., during Gulf Stream explorations in 1853. In 1867 systematic dredging in deep and shallow water was commenced on the assumption of the superintendence of the Survey by Prof. B. Pierce, who ordered the dredging. At the suggestion of Louis Agassiz, dredgings were made down to a depth of 1,000 fathoms. In Prof. Agassiz' report one of the richest grounds for deep-sea corals, lying off Cape Florida, was named Pourtales Plateau. In 1871 Pourtales published what is probably his best-known work, namely, his "Deep-Sea Corals" ("Ill. Cat. Mus.

Comp. Zool.," Harvard, No. iv.), a most excellent memoir, containing valuable disquisitions on the affinities of various genera, and excellent notes on the geographical distribution of the species and the nature of the bottom on which the dredgings were made. The memoir contains the results of some interesting researches on the relations of the Rugose to the Henactinian corals, in connection with the account of the aberrant genus Haplophyllia. The deep-sea Antipalliaria and Actiniadæ are described in it, as well as the stony corals, and the genus Pliobothrus, with great acumen, referred to its proper place amongst the Hydrozoa. A second memoir on deep-sea corals was contributed by Count Pourtales to the account of the zoological results of the *Hassler* Expedition, and many others on this and other zoological subjects are to be found in the *Bulletin* of the Harvard Museum of Comparative Zoology. The last work which appeared from his pen is the description of the plates of corals in the Report on the Florida Reefs, by the late Prof. Agassiz, which has just been published by Alexander Agassiz, by the permission of the superintendents of the U.S. Coast Survey. These plates are the most perfect and beautiful representations of corals that have as yet been published anywhere. They were drawn under the immediate direction of Prof. Agassiz.

Count Pourtales' name is indissolubly connected with deep-sea zoology by means of the genus Pourtalesia, named after him. Pourtalesia, a sea-urchin, one of the Spatangidæ allied to Ananchytes, was found by the *Challenger* expedition to be one of the most ubiquitous and characteristic deep-sea animals. Numerous species of the genus new to science were obtained by the expedition in deep water, some of them being of most extraordinary shapes. In conclusion it need only be added that Count Pourtales' kindness and good-nature were as much appreciated by English naturalists as elsewhere. He was most generous, always ready to give advice to naturalists working in the same most difficult field as himself, to supply them with specimens for investigation, and to discuss in the freest manner, with perfect impartiality, any question of systematic arrangement. He will be regretted by many friends in England, to which he paid frequent visits on his way to his native country, his last visit having been made in the spring of the present year.

H. N. MOSELEY

THE BRITISH ASSOCIATION AT SWANSEA

PREPARATIONS of the most unstinted kind are now being made at Swansea to insure to the members of the British Association a hearty, hospitable welcome, a good opportunity for the interchange of scientific results, and an instructive and healthful summer holiday during their visit in the week commencing on Wednesday, August 25 next. The Excursion Committee have already made arrangements for visiting the more interesting places in the district. The presidential address will be delivered on Wednesday, and a portion of Thursday, August 26, will be devoted to an excursion, limited to 200 members, to the celebrated iron-works and collieries at Dowlais, by special invitation of G. T. Clark, Esq., of Dowlais House. As this excursion will take place so early, members who intend joining in it should send in their names to the Local Committee as soon as possible before their arrival in Swansea. The return will be made in time for the reception *soirée*, which the Mayor of Swansea (Alderman John Jones Jenkins) will give in a fine wooden pavilion capable of accommodating 6,000 people.

Saturday, August 28, will be almost entirely devoted to excursions to the Gower Coast, Penrice Castle, Oxwich Bay, Arthur's Stone, Worm's Head, Bishopstone Valley and its underground river; Bacon Hole and other bone-caves, with the Bays; the Via Julia at Langhor, with ruins of castle, hospitium, sanctuary, and collieries and tin-works; Llandilo, Golden Grove, Carreg-Cennen, and Dynevor Castle; and by sea to Lundy Island and Ilfracombe.

Among the sciences geology this year takes the foremost place in the person of the distinguished president, Prof. Ramsay. There are few districts which comprise, within so small an area, so many geological formations as Swansea, and fewer still that offer such problems for solution and such advantages for useful study. To the west of the town an axis of old red sandstone is thrust up through lower shales and limestones, and the stratifications of the whole neighbourhood have been dislocated and curiously denuded. Along the coast of the Bristol Channel for twenty miles the grand limestone cliffs are fissured and distorted until they exhibit almost every variety of dip and strike. Here are bold projecting torrs, inhabited by sea-birds; undisturbed sandy bays, the realised dream of the bathing enthusiast; and the celebrated bone caves, explored by Buckland and Col. Wood, and described by Falconer. The list of their fossil contents is a long one, including, with the exception of the *Drepanodon* (*Machairodus*) of Kent's Hole, all the larger-sized extinct carnivorous and herbivorous mammalia found in all the caves of England put together. Of the smaller-sized genera, too, Bacon Hole and its neighbouring caverns contained representatives of every one save *Lagomys* and *Spermophilus*. In Mewslade Bay Mr. Prestwich discovered a fine example of raised beach, and beneath the sands of Swansea Bay are well-exposed beds of peat—roots, stems, branches, and leaves of the silver birch, and larger vegetation, the remains of a forest still retained in local tradition. On the other side of the bay, in these deposits, have been found antlers of splendid proportions, and British and Roman implements. The *Pholas candida* is found in the decayed wood, and the rocks at the western extremity of the bay abound with *Lithophagi*, the most numerous being *Saxicava rugosa*. The South Wales coalfield, the largest but one in Britain, is brought within easy workable range by a great east and west anticlinal and several smaller axes, and is so cut into by deep river valleys that the coal is generally worked by means of adits and galleries. As a consequence of this fortunate conformation of carboniferous strata and surface, the deepest coal-pit in the whole basin—Harris's Deep-Navigation Steam Colliery, in the Aberdare Valley—does not exceed 700 yards of vertical depth. There is still considerable difference of opinion as to the identity of certain beds which occupy the place of the millstone grit. To the north and east of the basin the grit is of the usual kind, save where the sands and gravels are compacted into a hard, whitish, quartz-like rock; but to the west of Swansea the equivalent beds change into siliceous under-clays, with coal-seams above them. At Lilliput, in Swansea Bay, there are two interesting outcropping ridges of this kind; and a little farther west still the coal-measures are found to lie conformably on the limestone, with the exception of those in the neighbourhood of Oystermouth Castle, where Sir Henry de la Beche found a section "of a kind of lenticular mass which fines off to the east and west," and "was formed under minor conditions of a different nature." At the head of the Swansea Valley there is said to be "a seam of coal occurring in the millstone grit." The Town hill sandstones, which form the highlands in the neighbourhood of the town, and the high bold escarpments of which may be traced almost all round the Basin, are equivalent to the Pennant rocks of the Bristol district. They are peculiarly interesting for the great quantity of *detrital* coal they contain. A few minutes' walk from the town to the quarries enables the geologist to see the curiosity *in situ*. Even the same coal pebble is sometimes seen to consist of coal of two distinct ages. The markings beautifully show how the newer plants were pressed down

around the coal-pebbles, which, from their greater hardness, have left their impress in the plants; but the crystallisation of the former has a uniform parallelism with the faces of its cleavage, while the cleavage of the older coal is parallel with the sides of pebbles, which occur in all positions, sometimes in the form of a rhomboid, with its edges and corners rounded by attrition. To the east of Swansea, near Southern Down and Dunraven Castle, there are remarkably fine exposures of Lower Lias full of *Gryphea incurva*, with large ammonites and belemnites. Last year an enormous slab was dug out of the Trias rocks at Shortlands, which bears five trifid impressions in a clear series. The length of each footprint is 9¼ inches, and it appears to have been made by "some solidly-built short-legged creature." A little further east the Rhætic Passage Beds are laid open for a distance of more than twenty miles to Penarth Headland, where *Carduum rhæticum* and numerous other characteristic fossils are found. Through these strata there are many railway cuttings and no less than six passenger stations, so that this district is perhaps the best in the whole country for the study of Rhætic strata in the fields. The peninsula of Gower, west of Swansea, besides offering such scientific attractions as bone-caves, underground water-courses, raised beaches, &c., is remarkable for the great beauty and variety of its scenery. Bold highlands and beetling cliffs alternate with heathery downs and commons, well wooded valleys through which trout streams flow, and rocky gorges, half hidden by luxuriant growths of fern. Tumuli, Druidic stones, Roman and Danish earthworks, and a round dozen Norman castles, dating for the most part from the days of William Rufus, lend additional charm to the district, which is peopled by the descendants of a colony of Flemings, who still retain many characteristic words, idioms, and customs, which the ethnologist may profitably study. The lonely granitic rocky island at the entrance to the Bristol Channel is associated with the geology of the Barnstaple district; but it has a history all its own, and a peculiar species of rat. Ilfracombe, on the Devonshire coast, is only two hours from Swansea Pier by a fast-going steam-boat. At Pembroke Dock, on the occasion of the visit, there will be a considerable number of notable ships and corvettes of war, and the *Great Eastern*. Minor excursions will run through the magnificent haven of Milford, and to Tenby, while arrangements are made to take fifty persons by road to St. David's City and Cathedral, with the ruined palace and colleges of the see of Menevia, in the utmost limits of Pembrokeshire.

All these excursions are fixed for Saturday, the 28th, and the Local Committee exact that all applications be sent in before 1 p.m. of the previous Thursday.

On the succeeding Thursday, September 2, the excursions, which are very numerous, will be for the most part to collieries and works. Perhaps the chief interest attaching to Swansea is its metallic industries, of which the district is a chief centre. The copper trade has flourished here for a century and a half to two centuries, but though various new processes have been tried from time to time, practically the oldest dry process, called the Welsh method, is still in use. It is affirmed that nine-tenths of the copper-smelting of the kingdom is done here. The sulphurous and arsenious fumes from these works have entirely denuded the hill-sides of verdure, but it cannot be shown that they injure human health. Among the many inventions for the consumption of this smoke, are washing it with water, collecting the sulphurous acid and converting it into sulphuric acid, and the use of deposit chambers and high chimneys. These processes may be seen at Hafod, the works of Mr. H. H. Vivian, M.P. The other excursions on the same day include various large tin works, where the whole of the processes of making the iron sheets and tinning them may be seen, and the visitors will be entertained at luncheon by the Worshipful Mayor at his Cwmbwrla Tin-plate Works; to the Landore Siemens Steel Works, where steel is made in gas regenerative furnaces by the Siemens-Martin process, and hammered and rolled and tested for rails, armour-plates, ship and boiler plates, knives, needles, wire, and all other commercial purposes, and visitors will be entertained at lunch by Dr. Siemens; to the Dyffwyn Collieries at Neath, the Navigation Colliery at Quaker's Yard, the Penrhiwceiber Colliery, Mountain Ash, &c., the most important coal winnings in the district, at each of which places visitors will be entertained. Visitors to Neath Abbey and district will take luncheon in the ruined refectory, and those to the Vale of Neath Waterfalls in the caves. At their Melyn Decorative Tin Works Messrs. Leach, Flower and Co. will show their extremely interesting processes and give a luncheon; Mr. J. T. D. Llewelyn, of Penllergare, will receive 100 visitors at his ancient and beautifully-situated residence five miles from Swansea; and Mrs. Crawshay will entertain on this day fifty visitors at Langorse Pool, Brecon. The oyster-dredging expedition in the Bay will start from Swansea Piers, and visit the Lighthouse Rock and Battery, luncheon being served on board. The neighbouring works, which may be easily reached from the town, include the manufacture of patent fuel in the old and in a perfectly new perforated form; sulphuric acid, phosphate manures, cobalt, silver, nickel, lead, spelter, sulphate of ammonia, oxalic acid, distillation of wood, alkalies, &c., &c.

Applications for tickets for these excursions on Thursday, September 2, must be made not later than the forenoon of the previous Monday.

Among the special attractions which will take place concurrently in Swansea are an agricultural show, a flower show, and especially an exhibition of local productions and processes. The exhibition of machinery will be on an extensive scale, and the greater part will be in motion. The more interesting portions of the machinery in motion and the loan exhibition of scientific instruments will be retained as an additional attraction to the second *soirée*.

The accommodation in the town and in the picturesque suburban watering-place of Oystermouth or The Mumbles is in every way ample, and the hospitality will be generous, but it would much facilitate the work of the Local Committee and add greatly to the satisfaction of visitors themselves if they would give timely and sufficient notice of their intention to be present on the occasion.

THE HIGH PLATEAUX OF UTAH[1]

UNTIL a few years ago the geography of the high grounds of the western part of North America was depicted, even on the best maps, in a manner which now appears almost like a caricature of nature. So much had been said and written about the Rocky Mountains that the popular imagination was wont to picture them as a colossal, rugged, and almost impassable range, extending continuously down the backbone of the continent, and serving generally as the watershed between the Atlantic and Pacific Oceans. The progress of research, however, dissipated this delusion by showing that, instead of one continuous chain of mountains, a vast area of country, extending from the British possessions far down into the Southern States, has been upraised into elevated plains or table-lands, and that these at various distances have been ridged up by lenticular mountain-chains, sometimes parallel, sometimes *en échelon*, and trending generally in a meridional direction. The term "Rocky Mountains" is now commonly restricted to the most easterly line of

[1] "Report on the Geology of the High Plateaux of Utah." With Atlas. By Capt. C. E. Dutton, U.S.A. Geographical and Geological Survey of the Territories. J. W. Powell in charge. (Washington, 1880.)

mountains, which serves as a divide or water-parting between the Atlantic slope and the regions lying to the west. But though the traditional glories of the Rocky Mountains have thus been dimmed, and though the most enthusiastic traveller through their still little-known solitudes must in fairness admit that they cannot boast among their innumerable ranges, hitherto visited and described, one which for variety and majesty of outline can be named with the Bernese Oberland, yet this merely nominal degradation is more than compensated by the discovery that these western territories contain a type of high ground to which there is probably no adequate parallel elsewhere on the face of the globe—a type so strange and overwhelming in its first aspect, so weird and almost incredible in its history, that the ordinary language of scenic description fails to convey the impression which the overawed beholder wishes to produce, and he finds himself obliged to borrow a new vocabulary, yet even with its aid is conscious that his narrative, exaggerated as it may seem, falls infinitely short of doing justice to the marvels he has seen.

To the portion of this region which, bounded by the Colorado Park Mountains on the east and by the ranges which border the Great Basin on the west, stretches from Southern Wyoming far into New Mexico and Arizona, the name of the Plateau Country has been given. It is drained mainly by the Colorado River and its tributaries. Its surface at lower levels than 7,000 feet above the sea is a blazing desert, bright with strange mineral colours—glaring red, livid purple, verdigris green, toned white, and ashy grey. On these plains hardly any vegetation grows. Not a solitary tree, save here and there a gnarled cedar, affords a scanty shade, and little but stunted sage-brush or prickly cactus in scattered tufts varies the eternal monotony of the burning soil. It is a region of perpetual drought, for the springs are believed not to average one in a thousand square miles. Yet the land is traversed by a network of rivers, which, however, wind along in profound chasms, to be crossed only by the birds of the air. So deep and sombre are many of these gorges (that of the Colorado being in some places more than a mile deep), that the very sound of their running waters never reaches the level of the plateau above. Only a dim daylight reaches the bottom, and the stars are said to be visible in certain narrow gorges at midday. But where the level of the plateaux rises high enough to condense some of the moisture which the air-currents carry across them the verdureless aspect of the lower plains is replaced by luxuriant forests and open glades carpeted with rich grass and wild flowers. So colossal, however, are the table-lands that some of them slope gradually out of the range of tree-growth to a height of from 11,000 to 12,000 feet above the sea, and almost lie within the limit of perpetual snow.

So far as yet known, the Plateau country reaches the fullest development of its extraordinary features in the southern portions of the Territory of Utah. This region was partially explored by Prof. Powell during his surveys from 1869 to 1874, and by the parties under Capt. Wheeler, especially by Mr. Howell and Mr. Gilbert, whose published reports form a valuable portion of the third volume of the "Geographical and Geological Explorations west of the One Hundredth Meridian," conducted by Capt. Wheeler. In 1875 Mr. Powell secured the services of Capt. Dutton for the investigation of a large volcanic tract among the Utah Plateaux as part of the survey under his direction. Capt. Dutton spent the seasons of 1875, 1876, and 1877 at the task assigned to him. We have now the result of this labour in the handsome quarto volume and beautiful atlas which have just appeared. This publication is undoubtedly one of the very best of the many admirable contributions to geology which have recently been made by the official surveys of the United States. With the aid of the letterpress, maps, and sections any geological reader can follow and realise to himself the almost incredible magnificence, as well as simplicity, of the structure of these high Plateaux.

The geology of the area may be briefly described as presenting a succession of nearly horizontal sedimentary formations from the upper Carboniferous up to the Eocene lacustrine deposits of the West, thrown into a succession of broad folds, cut into segments by a series of important faults, and overlaid towards the north by vast sheets of volcanic ejections, the whole of the rocks, aqueous and igneous, having been carved into valleys, gorges, escarpments, outliers, and isolated plateaux of the most imposing magnitude.

From the Carboniferous up to the top of the Cretaceous series there does not appear to be any general physical break in the continuity of the stratification. The Carboniferous rocks are only partially exposed, but their overlying beds—the singular deep purple, chocolate, slate, and brownish-red Shinarump group—attain a greater development, exhibiting their peculiar regularity of sedimentation and their sculptured terraces and outliers. These characteristic strata have been classed as Permian or Lower Triassic, but the researches of last year have, we believe, brought to light fossils which point unmistakably to their Permian age. An occasional want of conformability is observed between them and the overlying Trias, but as a rule the latter follow without discordance, and rise into the succession of bright red and orange sandstones and shales which constitute the great cliff-forming series throughout the Plateau country. A geologist accustomed to the scenery of the "New Red" plains of Central England may find it hard to believe that the Trias of Western America forms ranges of vermilion-coloured cliffs 1,000 or 1,500 feet high, projecting in vast promontories, retiring into deep bays, and stretching with the same brightness of colour and the same regularity of front for hundreds of miles. No very satisfactory line has yet been drawn between the Trias and the Jura. The latter series consists in the Plateau country of two members, the lower being a massive grey or white sandstone of great thickness, the upper a series of calcareous and gypsiferous shales from 200 to 400 feet thick. This sandstone, according to Capt. Dutton, was laid down over an area which cannot fall much short of 35,000 square miles, with an average thickness of more than 1,000 feet. Yet so persistent were the conditions of its deposit that from bottom to top, sometimes through a depth of nearly 2,000 feet, it everywhere consists of intricately false-bedded sandstone without layers or partings of shaly or other heterogeneous matter. From the Upper Jurassic calcareous beds distinctive fossils have been obtained.

The Cretaceous system presents here the usual massive development of sandstones and shales which form so prominent a feature in the geology of the West. The Lower Cretaceous Dakotah group is recognised by its lithological resemblance to the corresponding beds in Colorado and elsewhere, and by the occurrence of species of *Ostrea*, *Gryphæa*, *Exogyra*, *Plicatula*, &c. The overlying shales are identified with the Laramie group, which the author places as Upper Cretaceous. The whole of the Cretaceous series is more or less lignitiferous; a considerable number of workable coal-seams in it being already known. At the close of the deposition of the Laramie group the first important break in the succession of the rocks occurs. Extensive disturbance took place along the old Mesozoic shore-line which now bounds the Great Basin on the east, and this was accompanied and followed by such enormous denudation that the Cretaceous series, several thousand feet in thickness, was entirely removed and the oldest Tertiary strata accumulated on the exposed surface of Jurassic beds. Yet so local were these movements that in adjacent tracts the whole Cretaceous series of the region is present, and

appears to be followed without interruption by a conformable suite of Eocene strata.

The geographical changes that closed the Cretaceous period in the West were among the most important in the evolution of the American continent. Over many thousand square miles the floor of the sea was raised into land which has never since been again submerged. The lacustrine conditions which began in Cretaceous times now received a far greater development. The waters of the ocean, inclosed into inland seas, from brackish became fresh, and one or more lakes, of perhaps even greater dimensions than those of Eastern America, stretched between the heights of the Great Basin and the Rocky Mountains for as yet an unknown distance to the south. The history of these lakes has been studied by Hayden, King, Powell, and other geologists, and their marvellously rich ichthyic, reptilian, and mammalian fauna has been described by Leidy, Marsh, and Cope. Much remains to be done before the history can be regarded as even approximately filled in. In the meanwhile it is certain that this lacustrine area was undergoing slow subsidence during Eocene time, that sediment was being continually washed into it from adjoining mountains, that eventually 5,000 feet or more of strata were laid down over its site, and that the area of fresh water progressively diminished.

A new chapter in this eventful history is revealed by Capt. Dutton. He tells how in Southern Utah the lake, even as far back as the time of the Middle Eocene, was the theatre of volcanic discharges, and how these, after vast intervals of quiescence and almost incredible denudation, have been from time to time renewed down even to a period so recent that it can hardly be believed to date so far back as the days of Cortez and the Spanish Conquest. He shows that this volcanic district discloses a remarkable variety of phenomena, nearly every form of eruption being exhibited, and every great group of volcanic rocks being represented in it. The earliest volcanic rocks are tuffs, which he regards as probably derived in chief measure from the degradation of older lavas and the deposit of the resulting sediment on the floor of the lake. The next phase of volcanic activity was marked by the outpouring of masses of propylite and hornblende-andesite, and was succeeded by the third and grandest of all, when floods of trachytes and rhyolites, alternating with augitic andesites and dolerites, rolled far and wide over the plateaux. The author is doubtful whether these extravasations proceeded from Ætna-like summits or craters, and is rather inclined to look upon the larger deluges as having issued from local fissures. Certainly if any true lofty volcanic cones existed, all external trace of them has been completely effaced by denudation. The closing event in this long volcanic period, if indeed the record can be properly regarded as even yet closed, consisted in the emission of abundant streams of lava round the larger areas of previous activity. Capt. Dutton notices some remarkable examples of a feature which occurs on a much smaller scale in the volcanic region of the Rhine and Moselle. The basalt cones and craters whence the streams have emanated seldom appear at the base of the great cliffs or at the bottoms of the deep cañons. They are often crowded together near the crests of the terrace walls, or the lava has broken out from the face of a wall. They commonly lie near lines of fault, yet appear almost always on the uplifted instead of the depressed side of the dislocation. "The least common place for a basaltic crater is at the base of a cliff." Among the volcanic masses special attention is given to the enormous accumulations of conglomerate and tuff, which cover nearly 2,000 square miles of area, and range from a few hundred feet to nearly 2,500 feet in thickness. These vast piles of coarse detritus the author attributes to the atmospheric disintegration of previously erupted lavas, and he describes in detail the process by which similar conglomerates are at the present moment being formed by frost, rain, and mountain-torrents. The highly important observation was made by him among the older tuffs, that in some places they have been so metamorphosed that the product of alteration is a rock possessing all the ordinary characters of a lava.

The chronological sequence of volcanic rocks among the Plateaux of Utah has been recognised as obeying generally the order enunciated by Richthofen. Capt. Dutton, starting from this observed sequence, devotes two long chapters to theoretical discussion—one on the classification, the other on the origin of volcanic rocks. To his work in the field he has added careful labour indoors, especially studying the microscopical and chemical characters of volcanic rocks. No one can read his pages without recognising their suggestiveness, even though the conclusions reached in them may sometimes appear doubtfully valid. His remarks upon the texture of volcanic rocks (pp. 91–99) offer an excellent sample of his critical treatment. Pointing out how different may be the texture assumed by the same original magma according to whether the mass has cooled and consolidated at the surface or beneath it, he is disposed to regard the intrusive condition as a kind of intermediate stage between volcanic rocks which have issued above ground and non-eruptive masses which have remained inactive deep beneath it, and he regards the porphyritic texture as especially characteristic of this "qualified eruption." This generalisation is only partially supported by the volcanic history of Britain. Among our older Palæozoic rocks, indeed, the intrusive or injected masses very generally possess the porphyritic structure. But from the time of the Lower Old Red Sandstone onwards to the Miocene volcanic period inclusive, the intrusive sheets are for the most part non-porphyritic, while the porphyritic structure is found among the superficial lavas. The classification our author proposes is as follows:—

ACID SERIES—Group I. RHYOLITES.

Sub-group 1. Nevadite or granitoid rhyolite.
2. Liparite or porphyritic rhyolite.
3. Rhyolite proper, or hyaline rhyolite.

SUB-ACID SERIES—Group II. TRACHYTES.

Sub-group A. Sanidine Trachytes.
1. Granitoid Trachyte.
2. Porphyritic Trachyte.
3. Argilloid Trachyte.
4. Hyaline Trachyte.

Sub-group B. Hornblendic Trachytes.
5. Hornblendic Trachyte.
6. Augitic Trachyte.
7. Phonolite.
8. Trachytic Obsidian.

SUB-BASIC SERIES—PROPYLITE AND ANDESITE.

Sub-group 1. Hornblendic Propylite.
2. Augitic Propylite (?).
3. Quartz-Propylite.
4. Hornblendic Andesite.
5. Augitic Andesite.
6. Dacite or Quartz-andesite.

BASIC SERIES—BASALTS.

Sub-group 1. Dolerite.
2. Nepheline-dolerite.
3. Basalt.
4. Leucite-basalt.
5. Nepheline-basalt.
6. Tachylite.

The fifth chapter is entitled "Speculations concerning the Causes of Volcanic Action." The author propounds a very ingenious trial hypothesis, by which he believes the sequence of volcanic phenomena throughout at least the Rocky Mountain region may be explained. He assumes that volcanic phenomena are brought about by a

local increase of temperature within certain subterranean horizons. But, as he himself admits, this way of putting the case brings us no nearer to what may be the ultimate cause of such a local increase of temperature. He seeks to prove that all the phenomena of volcanic action point to local excitation, and that the observed order of appearance of lavas is what on this view might theoretically be anticipated. It would be beyond the necessary limits of this article to follow him into the details of his argument. But one or two points may be briefly referred to. He regards lavas as mainly derived not from primeval subterranean magmas, but rather from the fusion of such rocks as the crystalline schists and sedimentary formations. In the mechanics of eruptions he believes that the outpouring of lava does not arise from the expansion of vapours absorbed within the molten magma, but is merely a hydrostatic problem of the simplest order—the lava being forced out by the weight of the rocks overlying its subterranean reservoirs.

According to this hypothesis two preliminary conditions are requisite for an eruption of lava—the rocks must be fused, and their density in the molten state must be less than that of the overlying rocks. The author regards the observed order of appearance of the lavas to be determined by their relative density and fusibility, the more siliceous requiring a higher temperature to fuse them, and the more basic, though less refractory, demanding a higher temperature to give them such a diminution of density as will permit them to be erupted. At an early stage of eruption he holds that the acid rocks may be light enough to be ejected, but are not yet melted, while the basic rocks may be melted but must await further expansion by access of heat before they are capable of being poured forth. Hence some intermediate rock will be selected as the first to issue, and this rock the author believes to be propylite. A further increase of temperature produces hornblendic andesite and trachyte, and so on to the rhyolites, and finally the basalts. All rocks more basic than propylite are stated to present evidence of superfusion, these rocks, according to the theory, being those which possess so high a density as to demand a much greater accession of heat than that required for mere fusion, in order that they may become lighter than the overlying crust, and thus be erupted. Basalt in particular is cited as an example of a superfused rock.

The author tacitly assumes that the density of a lava at the time of its outflow is necessarily less than that of the rocks through which it ascends, otherwise it could not be erupted. It is a pity that no experimental demonstration of this assertion was given, for it forms so fundamental a postulate in the hypothesis. But even on the supposition that the lava is forced out by the descent of heavier overlying rock, what ought to be found as proof of this action? Ought we not to meet with abundant evidence of subsidence at volcanic foci? Every mass of lava derived from the local fusion of rocks at no great depth beneath the surface and driven out by the weight of rock overlying it, should have an accompanying and proportionate subsidence of the crust over the site of its source. Occasional proofs of collapse at volcanoes have long been known indeed, but admit of other explanation, such as "evisceration," to use Mr. Mallet's phrase. Instead of subsidence, the emission of volcanic material has generally been accompanied with upheaval. Capt. Dutton's own magnificent Plateaux of Utah should furnish copious proofs of a sinking or sagging of the nearly horizontal strata round the eruptive vents. But there is no trace of any structure of this kind in his instructive and carefully-drawn sections.

Again, the alleged superfusion of the basic rocks can hardly be admitted upon the evidence here brought forward in its support. The fact that thin streams of basalt have had a greater liquidity and have retained it for much greater distances than the acid lavas, has long been recognised. But as Reyer has recently suggested, it is capable of a different interpretation from that of superfusion. The author appeals also to the microscopic structure of basalt as favouring his view of former intense ignition. He cites, for example, the presence of glass particles, the absence of water-cavities, the isotropic base, the compactness and vitreous structure of this rock. But are not these characters present in far more striking development among the vitreous acid rocks, which he supposes to have had a temperature little more than sufficient for fusion? The exceptions which the author candidly admits to occur in the normal succession of lavas—basalts, for example, appearing before rhyolites, or quartz propylite and quartz-andesite simultaneously with the hornblendic members of their respective groups—seem fatal to the hypothesis.

From another point of view the idea that the order of emission of lavas has been determined in the way supposed presents great difficulties. The author affirms that "we must at least admit that the source of lavas is among segregated masses of heterogenous materials," and he supposes that "this arrangement would be well satisfied by a succession of metamorphic strata [gneiss, hornblendic and augitic schist] resting upon a supposed primitive crust or magma having a constitution approximating that of the basaltic group of rocks." But every known mass of metamorphic strata presents endless interstratifications of very various materials. By what process of selection are the elements of these diverse rocks grouped successively into definite volcanic compounds? How is it that out of the simmering subterranean broth just so much silica and alumina as are needed for one type are ladled out at one time, while a careful hand is kept on the lime, alkalies and iron-oxides, only the right proportions being dealt forth for each lava?

The remarkable persistence of type among the different species of lava all over the world has long been recognised. It is not easy to see how this persistence should exist, nor why there should not be far more varieties of lava and transitional grades between the varieties if they are due to the local melting up of various masses of heterogeneous materials within the crust.

The volume is illustrated by a series of heliotype plates, from photographs taken in the course of the survey, representing some of the more remarkable external forms assumed by the sedimentary and volcanic rocks. The Atlas contains a valuable series of topographical and geological maps. Among these a relief-map of the Plateaux, on the scale of five miles to an inch, is specially instructive. There are likewise two plates of sections, which bring before the eye in a clear and concise form the structural details of the region. In point of execution the plates of the atlas are altogether admirable. In his preface Capt. Dutton states that he undertook the task of exploration assigned to him with considerable diffidence in his ability to accomplish it. He must be congratulated on having achieved a signal success. His work bears everywhere marks of the most conscientious and painstaking industry, great acuteness of observation, and not a little literary skill in the marshalling and presentation of the facts observed. Let us hope that the arrangement by which he was enabled to exchange the routine duties of an army officer for geological field-work may be prolonged, and that in further prosecution of his explorations in the West he may live to issue other volumes as interesting and valuable as that which is noticed here.

ARCH. GEIKIE

TWO NEW PLANETARY NEBULÆ

A PLANETARY nebula in R.A. 18h. 25·2m. and Dec. − 25° 13′ was discovered at the Harvard College Observatory on the evening of July 13. A second

nebula was found on the following evening in R.A. 18h. 4·3m. and Dec. $-28°$ 12'. Both, but particularly the first, are only minute, and can be with difficulty distinguished from stars, except by their spectra. The discovery was not the result of accident but of a search with a direct vision prism inserted between the objective and eyepiece of the 15-inch telescope. A star appears as a coloured line of light, while a planetary nebula forms a bright point, and is recognised instantly in sweeping. Many hundred or thousand stars can thus be examined very rapidly, and a single nebula picked out from among them. This method promises to add very greatly to the list of known planetary nebulæ, which now number about fifty. Probably a systematic search for these objects crossing a considerable part of the heavens will be made at this Observatory. Our knowledge of that distribution will thus be greatly increased, and we shall know that their absence in certain parts of the sky is not due to an omission to look for them. Any planetary nebula as bright as a twelfth-magnitude star would probably be detected by the method proposed. Bright lines or other peculiarities in the stellar spectra will also be looked for.

Doubt has been thrown on many of the attempts to measure the parallax of planetary nebulæ owing to the haziness of the borders of these bodies. The minuteness of the disks of the nebulæ noted above could permit their positions to be determined with great precision, and would thus show a very minute parallax.

Cambridge, U.S., July 15 EDWARD C. PICKERING

NOTES

AN influential committee has been formed from among the members in the Section of Zoology of the Paris Academy of Sciences and others eminent in that department, to obtain subscriptions for a medal in honour of M. Milne-Edwards, the *doyen* of French zoologists.

A MOVEMENT has been set on foot to obtain subscriptions to a memorial fund in honour of the late Rev. J. Clifton Ward, whose name must be well known to our readers as a working geologist who made valuable contributions to his science. Mr. Ward, moreover, did great service in promoting a love of science in Cumberland, and the Association for the Advancement of Literature and Science, for which he did so much, has taken the fund heartily up. It ought to receive many subscriptions outside of the Association, and we commend it to the liberality of our readers. Subscriptions should be sent to the Rev. Canon Battersby, St. John's Parsonage, Keswick, and to Mr. Edwin Jackson, hon. treasurer, Keswick Library and Scientific Society. It is proposed to expend the fund in the erection of a mural tablet in the church of St. John, Keswick, and the remainder in laying the foundation of a fund for the education of Mr. Ward's two daughters.

IN answer to a question in the House of Commons as to the cause of the delay in the removal of the Natural History Collection from the British Museum to South Kensington, and when that removal would be completed, Mr. Walpole said he believed the delay had been caused by the facts that the building in which the collection was to be placed was not handed over to the Trustees of the British Museum until June, and that the grant made by the Treasury was not sufficiently large to cover the whole estimated expense for the cost of the removal. He believed the removal of the mineralogical, geological, and botanical collection would be completed by the end of the year or in the spring of next year; and that as far as the zoological collection was concerned, its removal would depend very materially upon the grant which the Treasury might feel itself at liberty to make for the purpose.

PROF. ED. VAN BENEDEN is at present at Bergen for the purpose of working out the embryonic development of the Lemming, which is likely to prove extremely interesting, because that of the guinea-pig is so abnormal.

A FEW months after Leverrier's death a commission was established for determining the best means of protecting collieries from fire-damp. The Commission has written a very long report recording the causes of 420 accidents. Sixty-four projects presented by private individuals have been examined, and some new instruments have been designed and are being constructed, viz., an anemometer by Vicaire, a manometer by Le Chatellier, and a registering apparatus for the quantity of air introduced into the galleries. But the composition of coal explosive dust has not been determined, nor the extent of its influence on catastrophes; the chemical analysis of Grisau has not been completed, and the salvage question has not been exhausted. The only substantial benefit is a compilation of mining regulations and a series of propositions which have been transmitted to the French Ministry, and will be laid before Parliament next session.

THE detailed programme of the annual meeting of the Iron and Steel Institute, to be held at Düsseldorf on August 25, 26, 27, and 28, is now published. The proceedings commence with a concert at the Tonhalle on Tuesday evening, August 24. On Wednesday there is to be in the morning a general meeting of members at the Tonhalle, where the institute will be received by the local authorities; in the afternoon a visit to the exhibition and to works near Düsseldorf; and in the evening the annual dinner of the institute at the Tonhalle. On Thursday and Friday there are to be general meetings in the morning for the reading and discussion of papers; the afternoons are to be devoted to excursions by special trains to various iron and steel works in the neighbourhood of Düsseldorf, followed by concerts in the evenings. The whole will be brought to a close by a Rhine excursion on Saturday, which is timed to bring members by 10.30 p.m. to Cologne, *viâ* Rolandseck, Bingen, and Coblentz. The general secretary is Mr. J. S. Jeans, whose address up till August 19 is 7, Westminster Chambers, Victoria Street; and after that date, Tonhalle, Düsseldorf.

THE Aldini gold medal (worth 1,000 lire) will be awarded by the Academy of Sciences of the Institute of Bologna to the best memoir on galvanism (animal electricity). Memoirs to be written in Italian, Latin, or French, and sent in before June 30, 1882.

THE Beneke prizes (first, 1,700 marks; second, 60 marks) of the Philosophical Faculty of Göttingen University are offered for investigation, theoretical and experimental, of diffraction phenomena in the case of non-homocentric light sources, as, especially, a circular and a square luminous surface of uniform brightness of the emitted simple or compound white light. Memoirs to be written in German, Latin, French, or English, and sent in before March 11, 1883.

A NEW process for obtaining stereotypes for printing has been discovered by M. Emile Jeannin, a sculptor of Paris, who proposes to employ for that purpose the material known as *celluloid*. The process of preparation takes only half an hour, when the types are once set up, and the plates thus produced are remarkably suitable for working on cylinder machines running at a high speed, being very light, flexible, and very durable. In this last respect indeed they surpass metal plates, affording, it is said, 50,000 impressions, whereas even an electrotyped copper plate backed with lead will only last for 30,000.

THE astronomical observatory established on the Trocadéro, is not the only scientific establishment which has found a home in the palace of the last Universal Exhibition. A number of microscopes have been arranged in a special room for the benefit of public instruction. The instruments lent by M. Joubert have been placed on the top of one of the towers, where a lift

has been arranged for helping visitors to find their way to this exalted situation.

A VERY curious telephonic experiment has been made in Switzerland on the occasion of the Federal *fête* of singers. A telephone had been placed in the Zürich Festhalle and two conductors connected with the Bâle telegraphic office, where a large audience had congregated. The distance from Bâle to Zürich is about 80 kilometres. The Bâle audience enjoyed the singing about as well as if they had been placed in the upper circle of an ordinary Opera House. At the end of the performance they proved their satisfaction by clapping hands, which the telegraphic wires transmitted with perfect fidelity to the Zürich performers.

A CREDIT of 25,000 francs has been voted by the French Parliament for establishing, on solid foundations, one signal at each extremity of the Melun base line, which was used by Delambre for measuring the distance from Dunkerque to Perpignan, and establishing the length of the metre. This operation was begun by Delambre and Laplace on 17 Vendémaire, An VI. (October 1797) and terminated in six weeks. This base has a length of 6,000 toises, and was situated on the margin of a public road going from Lieusaint to the crossing of the Brie and Paris roads.

A STRONG shock of earthquake was felt at Smyrna at 5.10 a.m. on July 29. The walls of the telegraph office were split in two or three places. Four or five houses were thrown down, and many others were much damaged by the oscillation. Two of the inhabitants were killed, and five or six injured. Much damage has also been done in the country near Smyrna. At Burnabat the shock caused eleven houses and several cafés to fall in. Two minarets were also thrown down and two people were killed, and ten more or less injured. Slight shocks continued to be felt from time to time.

THE new edition of the "Guide to the Gardens of the Zoological Society" brings the notices of the tenants of the Gardens up to the latest date. Mr. Sclater's name as editor of the Guide is a sufficient guarantee for its accuracy, while the numerous illustrations render it both attractive and instructive. By means of this very cheap Guide a visit to the Gardens will be rendered doubly enjoyable and profitable.

THE *Gardeners' Chronicle*, in advocating the establishment of school gardens where practicable, as an instrument of useful scientific education, refers to the success of such gardens in Bavaria, Belgium, Sweden, and other countries. In Sweden alone there are nearly 2,000 school gardens.

WE have received a copy of the *American Antiquarian*, No. 3, vol. ii., published at Chicago by Jameson and Morse, and edited by the Rev. S. D. Peet. It seems to us to be doing useful work in collecting information on early America, though several other serial publications in the States are doing the same thing to a greater or less extent. Excessive subdivision of labour of this kind in any special department is apt to embarrass the student.

THE subject of a depraved taste in animals is an interesting one, which has not been studied as much perhaps as it might. In human beings it would seem to depend on ill-health of either body or mind, but in animals it would seem as if it might be present and the animal enjoy good health. One remarkable instance in an herbivorous animal we can vouch for. It occurred in a sheep that had been shipped on board one of the P. and O. steamers to help to supply the kitchen on board, but while fattening it developed an inordinate taste for tobacco, which it would eat in any quantity that was given to it. It did not much care for cigars, and altogether objected to burnt ends; but it would greedily devour the half-chewed quid of a sailor or a handful of roll tobacco. While chewing there was apparently no undue flow of saliva, and its taste was so peculiar that most of the passengers on board amused themselves by feeding it, to see for themselves if it were really so. As a consequence, though in fair condition, the cook was afraid to kill the sheep, believing that the mutton would have a flavour of tobacco. Another very remarkable case has just been communicated to us by Mr. Francis Goodlake: this time a flesh-eating animal in the shape of a kitten, about five months old, who shows a passionate fondness for salads. It eats no end of sliced cucumber dressed with vinegar, even when hot with cayenne pepper. After a little fencing it has eaten a piece of boiled beef with mustard. Its mother was at least once seen to eat a slice of cucumber which had salt, pepper, and vinegar on it. The kitten is apparently in good health, and its extraordinary taste is not easily accounted for. Even supposing it once got a feed of salmon mayonaise, why should it now select to prefer the dressing to the fish?

THE *American Journal of Microscopy and Popular Science* (vol. iv., 1879, of which is before us) is now published monthly. Besides various original articles, some of which are illustrated, it contains from time to time abstracts of the transactions of many of the microscopical societies of the United States. This journal, without aiming at a standard to be compared with the European journals relating to microscopical science, seems to perform its part well, and we are glad to know that it has done much to encourage the use of the microscope in the States. We may trust soon to see some results from all this work, and to find the chief articles in the *American Journal of Microscopy* the result of original researches among the minute algæ, fungi, rhizopods and infusoria of America, and that the extracts from the various European journals may be relegated to a second place. There is without doubt an abundant field for work of this nature in America—witness Leidy's volume on rhizopods—nor do we understand why the labourers should be so few.

THE *Ceylon Observer* has published letters from Mr. Morris, who was recently transferred to the Botanical Gardens, Jamaica, detailing his recent experiences with regard to the cultivation of cinchona, and his views on the coffee-leaf disease in Ceylon. He still maintains the usefulness of dusting with lime and sulphur.

FURTHER rich discoveries of gold are reported to have been made in Northern Queensland and Tasmania. It is also stated that gold has been discovered under the basalt in the Brook Mountains, in New South Wales, the first instance of the kind in the colony.

IN a memoir published by the *Revue Scientifique*, M. Ernest Maindron, archivist of the Academy of Sciences, shows that the Academy is possessed of an income of 116,000 francs, to be awarded in about thirty prizes, of which the periodicity varies from one year to ten.

FROM the Fifth Annual Report of the Hertfordshire (formerly the Watford) Natural History Society, we are glad to learn that that society is now prosperous, its membership having greatly increased during the past year.

THE *Proceedings* of the Nottingham Literary and Philosophical Society for 1879–80 is mainly occupied with the president's (Rev. R. A. Armstrong) address on "What is Science?" papers on "Sandstones," by Mr. J. H. Jennings; "Philosophy in the Middle Ages," by Mr. G. B. Kidd; and "Structure of Molecules," by Mr. J. J. Harris Teall. A large number of lectures on scientific subjects were given during the session, and several special papers read in the Natural History Section.

THE *Transactions* of the Norfolk and Norwich Naturalists Society for 1879-80 contains a favourable report of the present

condition of the Society. The address of the president, Mr. T. Southwell, is on the Extinction of Native Races. Among other papers of interest are: "Notes on Collecting Lepidoptera in Norfolk, 1878," by Mr. F. D. Wheeler; "Discovery of Remains of *Emys lutaria* in the Mundesley River-bed," by Mr. H. B. Woodward; The Bird-Life and the Geology of the Shiant Isles, by Mr. Harvie-Brown and Prof. Heddle respectively; Notes on Hawking in Norfolk, by Prof. Newton and Mr. J. E. Harting; Ornithological Notes and Meteorological Observations.

THE *Proceedings* of the Liverpool Naturalists Field Club for 1879-80 contains notes of the excursions and meetings of the Society. The only papers given are by the president, the Rev. H. H. Higgins, one being "Biographical Sketches in Zoology, from its Origin to its Union with Botany in the Science of Biology."

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. J. Anson; a Side-Striped Jackal (*Canis lateralis*) from East Africa, presented by Commander Owen, R.M.S. *Anglian*; aCommon Ocelot (*Felis pardalis*) from Mexico, presented by Mr. A. L. Schütte; two Common Peafowls (*Pavo cristata*) from India, presented by Mrs. Joseph Hoare; four Globose Curassows (*Crax globicera*), a Little Guan (*Ortalida motmot*) from British Honduras, presented by Mr. F. P. Barlee, C.M.G.; ten Amaduvade Finches (*Estrelda amandava*) from India, presented by Mr. J. W. Wilson; a Mississippi Alligator (*Alligator mississippiensis*) from North America, presented by Mr. T. L. M. Rose; two Horrid Rattlesnakes (*Crotalus horridus*) from Nicaragua, presented by Messrs. Holt, Lord, and Co.; an Anaconda (*Eunectes murinus*) from South America, presented by Mr. G. H. Hawtayne; a Bonnet Monkey (*Macacus radiatus*) from India, an Arctic Fox (*Canis lagopus*) from the Arctic regions; a Nilotic Crocodile (*Crocodilus vulgaris*) from Africa, deposited; a Nylghaie (*Boselaphus pictus*) from India, a Collared Peccary (*Dicotyles tajaçu*) from South America, two Common Otters (*Lutra vulgaris, jv.*), British; a Ground Hornbill (*Bucorvus abyssinicus*), an Elate Hornbill (*Buceros elatus*) from West Africa, a Virginian Eagle Owl (*Bubo virginianus*) from North America, a White-necked Crow (*Corvus scapulatus*) from Africa, purchased; a Collared Fruit Bat (*Cynonycteris collaris*), born in the Gardens.

ON CURRENTS PRODUCED BY FRICTION BETWEEN CONDUCTING SUBSTANCES, AND ON A NEW FORM OF TELEPHONE RECEIVER[1]

IN a communication to the Royal Society of Edinburgh of date January 6, 1879, I showed that "electric currents were produced by the mere friction between conducting substances." The existence of these currents can be easily demonstrated either by a telephone or a Thomson's galvanometer. I have since found that these currents are, for all pairs of metals which I have yet tried, in the same direction as the thermo-electric current got by heating the junction of the same two metals. They are also, approximately at least, stronger in proportion as the metals rubbed are far apart on the thermo-electric scale—the strongest current, as far as I have yet observed, being got by rubbing antimony and bismuth together. These observations clearly point to a thermo-electric origin for the currents; but it is possible that they may be due partly to the currents suggested by Sir William Thomson as the cause of friction, and partly, also, to contact force between films of air or oxide adhering to the surfaces of the metals.

Having ascertained that these friction-currents are of some strength and fairly constant, I proceeded to make several kinds of machine for producing currents on this principle. One of them consists of a cylinder of antimony, which can be rotated rapidly, while a plate of bismuth is pressed hard against it by a stiff spring. When this machine is included in the same circuit with a microphone and a Bell telephone, the current got from it is quite sufficient to serve for the transmission of musical sounds and also loud speaking. The transmitter, which I have found most serviceable in my experiments, is made by screwing two small cubes of gas-carbon to a violin, and placing between them a long stick of carbon pointed at both ends, the points being made to rest in conical holes in the carbon cubes. The looseness of the contact is regulated by a paper spring. This forms an excellent and handy trasmitter for all kinds of musical sounds, and also serves very well for transmitting speech.

[1] Abstract of a paper read before the Royal Society of Edinburgh by James Blyth, M.A., F.R.S.E., on May 3, 1880.

Seeing that friction between metals clearly produces a current, it seemed natural to inquire if the converse held good, that is, if a current from a battery sent across the junction of two metals affected the friction of the one upon the other. I have tested for this in a variety of ways, and the results obtained leave me in doubt whether to attribute them to variations in the friction, or to actual sticking produced by fusion of the points of contact through which the current passes. The most noticeable effect is produced when one of the rubbing bodies is a mere point, and the other a smooth surface of metal. This led me to make a modification of the loud-speaking telephone of Mr. Edison, in order to get audible indications of changes of friction produced by the passing of a variable current. It consists of a cylinder of bismuth accurately turned and revolving on centres. The rubbing-point is made of a sewing-needle with its point bent at right angles, and its other end attached to the centre of the mica disk of a phonograph mouthpiece. It is evident that this is only a loose contact, which can be perpetually changed. When this apparatus is included in the circuit with the violin-microphone and three or four Bunsen cells, the violin sounds, as was to be expected, are heard proceeding from the loose-contact, even when the cylinder is not rotated. They are increased, however, in a remarkable degree by rotating the cylinder slowly, so much so that a tune played on the violin can, with proper care, be distinctly heard all over an ordinary room.

With regard to the explanation of this effect, it is evident, that electrolysis can in no sense come into play, as is supposed to be the case in Edison's instrument. I am inclined to look for the explanation rather in the direction of the Trevelyan rocker, although the circumstances are considerably different in the two cases. In the rocker we have the heat passing from a mass of hot metal through two points of support to a cold block, whereas, in the other case, the heat is only intense at the points of contact, the rest of the metals being comparatively unaffected. The variations in the current produced by the transmitting microphone must cause corresponding variations in the heat at the point of contact of the needle with the cylinder, and this again produces a mechanical movement of the pressing point, as well as of the air surrounding it, sufficient to give forth sound-waves. If such be the case the effect should be different for different metals, those answering best which have the lowest thermal conductivity and also the lowest specific heat. That this is really so is shown by substituting cylinders of other metals for the bismuth, all other things remaining the same. In this way I have compared lead, tin, iron, copper, carbon, and find that they all give forth the simple loose contact-sound when the cylinder is stationary, but that it is only with bismuth that there is any very great intensification of the sound when the cylinder is rotated. Now, by consulting the appropriate tables I find that bismuth is a fraction lower than any other common metal in specific heat, while it is much below them all in thermal conductivity. This seems to bear out my explanation to a certain extent.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The subject for the Sedgwick Prize essay, 1883, is "The Classification of the Cambrian and Silurian Rocks." The prize is open to all graduates of the University of Cambridge who have resided sixty days during the twelve months preceding October 1, 1882. The essays must be sent in to the Registrary on or before October 1, 1882.

SCIENTIFIC SERIALS

Proceedings of the Academy of Natural Sciences of Philadelphia. Part 1, January to April.—Thomas Meehan, on disarticulating branches in Ampelopsis (the annual growth is dis-

articulated at just one node above that one made the previous year, the branch thus gaining but one node in the year. This reminds one of the South Pacific Vitis, which produces tubers on the end of the branches, and at the end of each season disarticulates them).—On germination in acorns (in *Quercus virens*. Mr. Mazyck has noticed that the two petioles instead of being short were produced to a length of 1½ inches before the plumule and hypocotyledonary portions of the young plant commenced their growth, and a small tuberous projection nearly one-fourth the size of the acorn preceded the growth downwards of the radicle and upwards of the plumule. The cells in all of these were gorged with starch).—Dr. Leidy, notice of *Filaria immitis* in the dog, and on a Filaria reported to have come from a man. —W. N. Lockington, on the Pacific species of *Caulolatilus*.—Heilprin, Angelo, on the stratigraphical evidence afforded by the tertiary fossils of the peninsula of Maryland.—J. S. Kingsley, carcinological notes: I. (chiefly relates to the genus Thelphusa, describes two new species from Ceylon and one from West Africa; also a new species of Dilocarcinus. II. Revision of the Gelasimi, plates 9 and 10).—Dr. Allen, description of a fœtal walrus, and on the mammæ of bats.—Dr. R. Bergh, on the nudibranchs of the North Pacific Ocean, with special reference to those of Alaska, Part 2, plates 1 to 8.—Howard Kelly, on a sartorius muscle in the gorilla. This muscle was reinforced six inches from its origin by a muscular slip a quarter of an inch in breadth; it arose at the lower part of the middle third of the femur, between the origin of the quadriceps extensor and the insertion of the adductors joining the sartorius opposite the knee joint.—J. H. Redfield, on *Rochelia patens* (Nuttell), decided by Dr. Gray to be *Echinospermum floribundum*.—Report on plants introduced by means of the International Exhibition 1876.

Bulletins de la Société d'Anthropologie de Paris, tome 3, fasc. 1, 1880.—The present number contains the address of M. Sanson, president of the Society for 1880.—A communication from M. Mantegazza, on the Lapps.—A paper by M. Emile Goldi, on the migration of races in Egypt, which gave rise to an animated discussion, in which Mad. C. Royer opposed the author's view of the Asiatic origin of the Egyptian races.—M. Topinard proposed new methods for obtaining means differing from those suggested by M. Broca, which he considers to be based upon too small numbers.—M. Robin, Inspector of Primary Instruction in the Departement de Loir-et-Cher, invites the attention of the Society to the question whether it would not be desirable, to require from teachers in the public schools reports of the stature, growth, &c., of the pupils under their observation. M. Broca was of opinion that anthropological characteristics are of little value except in the case of adults, and that the important question of growth can only be satisfactorily considered when large numbers of children are simultaneously submitted to observation.—This number of the *Bulletins* devotes nearly seventy pages to the reprint of the "Inventory of the Megalithic Monuments of France," in which we have the combined result of the carefully-conducted observations of the General Commission for the registration of these remains, which was formally appointed by the Minister for Public Instruction in November, 1879. In this survey the country was divided into six sections, each of which was placed under the direction of one of the commissioners, while the general work was further subdivided into two groups, those of erratic boulders and megalithic monuments.—The last paper, by M. Paul Broca (on a new instrument invented by himself, and named "le goniomètre d'inclinaison et l'orthogone"), has a specially melancholy interest from the fact that it is connected with some of the latest work done by this eminent savant before his death.

Journal of the Franklin Institute, July.—The belt-dynamometer of Dr. C. W. Siemens, by R. Briggs.—High railway speeds, by W. B. Le Van.—Economic vaporisation of a boiler, by Chief Engineer Isherwood.—Progress of the dephosphorisation of iron, by F. Gautier.—The involute of the circumference of a circle, by L. D'Auria.—A new pendulum suspension, by L. H. Spellier.—The puddling process, past and present, by P. Roberts, jun.

Bulletin de l'Académie Royale des Sciences (*of Belgium*), No. 5.—On a whale caught on the coast of Charleston (South Carolina) on January 7, 1880, by M. Van Beneden.—An application of accidental images, by M. Plateau.—Note on the illumination of mines with phosphorescent sulphides, by M. Montigny.—Researches on the property possessed by solid bodies of welding by the action of pressure, by M. Spring.—On the line of (so called) helium, by Abbé Spée.—Excretory apparatus of the Trematodes and Cestoides, by M. Fraipont.—Discovery of hæmoglobin in the aquiferous system of an Echinoderm, by M. Foeltinger.

SOCIETIES AND ACADEMIES

EDINBURGH

Royal Society, June 21.—Prof. Maclagan, M.D., vice-president, in the chair.—Prof. Chrystal read a paper on a differential telephone, and on the application of the telephone to electrical measurements. A differential telephone was exhibited. It differed from an ordinary telephone in much the same way that a differential galvanometer differs from an ordinary single-coiled one. Two thin wires were twisted together and wound round the magnet in the usual way. It was shown that when an interrupted current passed in opposite directions through the two coils of the differential telephone no sound was heard. In using the instrument, its two coils were put into the two branches of a multiple arc, which was inserted in the circuit of the interrupted current. The interrupted currents of the two branches passed in opposite directions through the coils. The conditions for perfect compensation were not only that the resistances of the two branches must be equal, but also that their co-efficients of self-induction must be the same. If only one of these conditions was fulfilled a minimum of sound could be got, but absolute silence was impossible. The necessity for this twofold adjustment had not been hitherto sufficiently recognised; and it was to its neglect that the main difficulties in using Hughes' induction-balance were no doubt to be referred. Some years ago Prof. Chrystal had worked out the mathematics of the subject, but had been unable till recently to corroborate his results by experiment. Prof. Chrystal then proceeded to indicate how such a differential telephone could be applied to the measurement of coefficients of self-induction in terms of an arbitrary unit. Two coils were prepared of exactly the same resistance, but one was so wound as to have practically no self-induction. The self-induction of the other was the arbitrary unit mentioned above. In the rough model shown, two coils, whose distance apart could be varied at will, were introduced into each branch of the multiple arc above referred to, and were first adjusted so as to produce perfect compensation in the differential telephone. The other two equal resistance-coils were then introduced, one into the circuit of each induction pair, with the necessary effect of destroying the compensation. By a readjustment of the induction of one of the pairs, compensation was again secured, the change of distance of the coils of the altered pair corresponding therefore to the arbitrary unit. The two single coils were then removed, a fresh compensation obtained by alteration of the other induction pair, the single coils again introduced, a fourth compensation effected and a second stage reached in the formation of a graduated scale of self-induction in terms of an arbitrary unit; and so on till a complete scale was formed. Prof. Chrystal further pointed out how his instrument might be used for measuring capacities, and for investigating the real nature of the *opposition* offered by electrolytes to the passage of electric currents.—Prof. Tait communicated a paper on the determination of the specific heats of saline solutions, by Mr. Thomas Gray, B.Sc.—Mr. J. Y. Buchanan described a "navigational sounding-machine" of very simple construction. A glass tube, closed below by a plug kept sufficiently tight by a close-fitting india-rubber band, was provided above with a peculiarly-formed capillary orifice. The tube was first allowed to fill with air, and then sunk to the required depth in the sea. The air was compressed under the increased pressure, and the water began to trickle in from above. The quantity of water which so gained admittance was the datum from which the pressure, and therefore the depth, could be calculated. The water was removed by taking away the bottom plug; and the instrument was once more in a state suitable for use. Mr. Buchanan also communicated some experiments on the compressibility of glass. The value he obtained was greater than that obtained by Grassi by 2½ per cent.—Dr. Macfarlane read a short paper entitled "Suggestions on the Art of Signalling." He advocated the use of *three* qualities or symbols in preference to the dot-and-dash or two-symbolled alphabet of Morse, arguing that such a system would be found more rapid than the latter.—Dr. R. M. Ferguson communicated a note on the wire telephone, following

up the results obtained formerly by himself and those more recently arrived at by Preece and Chrystal. He showed that the sound emitted by a stretched iron wire through which an interrupted current was passing varied in a remarkable way with temperature, reaching a most evident maximum about a dull red heat. This variation he regarded as being in some way connected with the magnetic properties of iron, and on that ground criticised Prof. Chrystal's explanation of the De la Rive phenomenon as being due to rapid contractions and dilatations of the thin wires through which the current passed. In the remarks which followed Prof. Chrystal admitted the influence of magnetism in the case of the *iron*, a thick wire of which was as efficient as a thin wire; but in the case of what are usually reckoned non-magnetic metals, only *thin* wires of which are efficient for reproducing continuous sounds, he still thought that the true explanation was to be found in their changes of length. The altogether *peculiar* action of iron—though probably nickel and cobalt would have a similar action—seemed to him rather to favour this view than the other.

BOSTON, U.S.A.

American Academy of Arts and Sciences, June 9.—Prof. Joseph Lovering, vice-president, in the chair.—Dr. A. Auwers of Berlin, and Prof. Descloizeaux of Paris, were elected Foreign Honorary Members.—The Rumford medal was conferred on Prof. Josiah Millard Gibbs for his researches in thermodynamics.—The Hon. Charles Francis Adams resigned the office of president of the Academy, and Prof. Joseph Lovering was elected to the chair.—Dr. Oliver Wendell Holmes was chosen vice-president, Prof. Josiah P. Cooke corresponding secretary, and Prof. John Trowbridge recording secretary.

PARIS

Academy of Sciences, July 26.—M. Edm. Becquerel in the chair.—In name of a committee lately formed, M. de Quatrefages asked the Academy to open a subscription with the view of striking a medal in honour of M. Milne-Edwardes' services to science. Agreed.—Apparatus for measuring the heat of combustion of gases by detonation, by M. Berthelot. It consists essentially of a bomb suspended in a calorimeter.—On the dissolution of chlorine in water, by M. Berthelot. His observations point to the existence of a perchloride of hydrogen, probably a trichloride.—On the theory of the sines of superior orders, by M. Villarceau.—On the same, by M. Farkas.—Substances addressed to the Museum mistakenly as meteorites, by M. Daubrée. Most frequently they are scoriæ from works, and pyrites; but iron ores and a variety of substances are sent, and the senders are often men of scientific note. Bolides are often thought to fall near, while really far away.—On the successive transformations of the photographic image by prolongation of the luminous action, by M. Janssen. Beyond the second neutral state he gets a second negative image (requiring a million times the luminous intensity for the first), and a third neutral state, with uniform dark tint.—Report on the project contained in documents deposited by M. de Lesseps for the interoceanic canal. This reviews the past history of the question.—Report on a memoir by Dr. Companyo, entitled "Project of Organisation of the Service of Health of the Panama Interoceanic Canal," by M. Larrey.—M. Boutigny described some new experiments on the spheroidal state.—On the transformation of linear differential equations, by M. Appell.—On a property of algebraic functions and curves, by M. Pickard.—On the causes of interior alteration of steam boilers, by M. Lodin. From experiments with iron wire in sealed tubes holding various waters, he finds the predominant cause of oxidation to be the oxygen of dissolved air, and that this is not more intense in the case of distilled water than of calcareous, but the opposite. The action of some disincrustants is studied.—On a method of direct autocollimation of objectives and its application to measurement of indices of refraction of the glasses composing them, by M. Martin.—On the employment of the spherometer, by the same. He has improved it in certain points.—On the causes of terrestrial magnetism, by M. Lemström. He magnetises a vertically-suspended bar of soft iron, by rapid rotation of a paper tube, with two concentric walls round it. The earth he supposes similarly magnetised by rotating in a space of ether.—On an electrodynamic paradox, by M. Gérard-Lescuyer. When the current of a dynamo-electric machine (Siemens) is sent into a magneto-electric machine (Gramme), the latter moves with increasing speed; then it slackens, stops, and turns in the opposite direction; this action is reversed in turn, and so on. The polarities of the inductors are reversed.—Researches on ozone, by MM. Hautefeuille and Chappuis. The tension of transformation of ozone in oxygen under the silent discharge increases rapidly with fall of temperature. In passing from 20° to − 23° it is nearly doubled. Increase of pressure favours the production of ozone.—On a new isomeric modification of hydrate of alumina, by M. Tommasi.—Observations on M. Bourgoin's note on the ultimate action of bromine on malonic acid, by M. Petrieff.—On the molecular heat and volume of rare earths and their sulphates, by MM. Nilson and Petersson.—On a new fermentation of glucose, by M. Boutroux. What he called *lactic* fermentation in a note on March 4, 1878, he now calls *gluconic*.—Absorption and elimination of poisons in cephalopoda, by M. Yung. Absorption takes place most promptly by the branchiæ (very weakly by the skin), and according to osmotic power of the substances. Elimination is by the liver and the sac of black liquid.—Velocity of transmission of the motor excitation in the nerves of the lobster, by MM. Fredericq and Vandevelde. It is about 6m. per sec. at + 10° to + 12° C., and 10 to 12m. at + 18° to + 20°.—On the differential sensibility of the eye for small luminous surfaces, by M. Charpentier. As the two illuminated surfaces are diminished the power of distinguishing them greatly increases.—Contributions to palæozoic flora, by M. Crié.—The Loire, the Loiret, and subterranean currents of the Valley of Orleans, by M. Sainjon.—On the bed of cut flints at El Hassi (Algerian Sahara), by M. Rolland.—On the means of obtaining photographic negatives in a free balloon, by M. Desmarets. In a recent ascent he used an obturator like M. Janssen's.

GÖTTINGEN

Royal Society of Sciences, April 7.—On the conditions of geysers, by H. O. Lang.—On the extension of Abel's theorem to integrals of any differential equations, by L. Koenigsberger.

May 1.—Notices on some Australian volatile oils, by Baron von Müller.—Analysis of electric discharges, by W. Holtz.—An improved centrifugal machine for schools, by the same.

June 5.—On three-point contact of curves, by H. Schubert.—On those algebraic equations between two variable quantities which allow a number of rational univocal reversible transformations into themselves, by G. Hettner.

July 3.—Voltaic element of aluminium, by F. Wöhler.—On the functions which arise by inversion of solutions of linear differential equations, by L. Fuchs.—On algebraic logarithmic integrals of non-homogeneous linear differential equations, by L. Koenigsberger.—On a new arrangement of the magnets of a galvanometer, by K. Schering.

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